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PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Applicant: HEED, Bjorn) Examiner: Leo
Serial Number: 08/737,042) Art Unit: 3743
Filed: October 30, 1996)
For: HEAT EXCHANGER AND METHOD FOR ITS MANUFACTURE)
Docket Number: 5098)

SUBSTITUTE APPEAL BRIEF

Mail Stop Appeal Brief – Patents
Commissioner of Patents
Box 1450
Alexandria, VA 22313-1450

July 11, 2005

Sir:

In response to the Notification of Non-Compliance with the Requirements of 37 CFR §41.37(c) dated 21 January 2005, Applicant submits this Substitute Appeal Brief. Accompanying this Substitute Appeal Brief is a Petition for a 5-month extension of time up to and including 21 July 2005. Accordingly, this Substitute Brief is timely filed.

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HEED, Bjorn
Serial Number: 08/737,042
July 11, 2005
Page 2

This Substitute Brief corrects the Section headings to comply with 37CFR §41.37(c).

This is an Appeal Brief from the Final Rejection dated November 18, 2003 of Claims 5 and 7 -11. Applicant filed a Notice of Appeal on March 17, 2004. The Notice of Appeal was received by the USPTO on March 22, 2004. Accompanying this brief is a petition of a five-month extension of time for May 22, 2004 up to and including October 22, 2004 and the fee set forth under 37 CFR 1.17(a)(5). Accordingly, this brief is timely filed on October 22, 2004.

TABLE OF CONTENTS

I.	Real Party in Interest	5
II.	Related Appeals and Interferences	5
III.	Status of the Claims	5
IV.	Status of the Amendments	5
V.	Summary of the Invention	6
VI.	Grounds of Rejection to be Reviewed on Appeal	12
	A. Issues	12
	B. Grouping of Claims	12
VII.	Argument 13	
	A. Claims 5 and 9 are Patentable Over <i>ACV</i> in View of <i>Usher</i> ...	13
	i. One Skilled in the Art Would Not Combine <i>ACV</i> with <i>Usher</i>	14
	ii. <i>ACV</i> and/or <i>Usher</i> Alone or in Combination Do Not Teach a Heat Exchanger with All the Limitations of Claims 5 and 9	16
	B. Claims 7 -8 and 10 - 11 are Patentable Over <i>ACV</i> in View of <i>Usher</i> in Further View of <i>Hultgren</i>	19
	i. One Skilled in the Art Would Be Led Away From The Combination of <i>ACV</i> , <i>Usher</i> and <i>Hultgren</i>	19
	ii. <i>ACV</i> , <i>Usher</i> and/or <i>Hultgren</i> Alone or in Combination Do Not Teach a Heat Exchanger with All the Limitations of Claims 7 - 8 and 10 - 11 ...	20
VIII.	Conclusion	21

X.	Appendix	A1
	Claims	A1
	SU 800500 (ACV)	A4
	Translation of SU 800500 (ACV).	A8
	GB1339542 (<i>Usher</i>)	A11
	U.S. Patent No. 4,407,357 (<i>Hultgren</i>)	A22
	FIGURES 1 – 7	A31
	<i>In re Lee</i> , 277 F.3d 1338 (Fed. Cir. 2002)	A36
	<i>In re Fritch</i> , 972 F.2d 1260 (Fed. Cir. 1984)	A47
	<i>ACS Hosp. Sys., Inc. v. Montefiore Hosp.</i> , 732 F.2d 1572 (Fed. Cir. 1984)	A55

I. Real Party in Interest

The real party in interest is inventor Bjorn Heed.

II. Related Appeals and Interferences

Applicant's legal representatives submit that there are no known appeals and interferences related to this appeal.

III. Status of the Claims

Claims 5 and 7-11 are pending in the above application. These claims presently stand rejected, pending appeal.

Claims 5 and 9 were rejected under 35 USC §103(a) as being unpatentable over SU 800,500 (ACV) in view of GB 1339542 (*Usher*).

Claims 7-8 and 10 - 11 were rejected under 35 U.S.C. § 103(a) as being unpatentable over ACV in view of *Usher* and in further view of US Patent No. 4407357 (*Hultgren*).

Applicant appeals to the Board of Appeals from the Office Action dated November 18, 2003 finally rejecting Claims 5 and 7-11.

IV. Status of the Amendments

No claims were amended after Final Rejection. An amendment to the specification was filed contemporaneously with the brief. Amendments were made to the specification to address the Examiner's objections that the specification lacked section headings and that there was no description in the specification related to Figures 5-7. No new matter was added.

V. Summary of the Invention

The present invention relates to a recuperative heat exchanger for the transfer of heat between two media through a heat transferring wall, and a method of producing such a heat exchanger. Heat exchangers are used for the transfer of heat between two media flows of different temperatures. In a recuperative type heat exchanger, heat is transferred from the hot medium through a separating wall to the cooler medium.

If the heat exchanger is to serve its function of transferring heat it is important that the heat transfer surface area is as large as possible. This is often accomplished by dividing the media flows into multiple parallel part flows moving inside alternately juxtaposed passageways to form a unit with a large transfer surface area within a limited volume.

Except when subject to boiling or condensation the media change their temperature as they pass through the heat exchanger. The temperature of the hot medium gradually decreases and the temperature of the cooler medium gradually increases. When the temperature difference between the media is small it is important that the flow geometry in the heat exchanger is such that the hottest part (the beginning) of the hot flow heats the hottest part (the end) of the cool flow and that the coldest part (the end) of the hot flow heats the coldest part (the beginning) of the cool flow. The use of countercurrent flow geometry in the heat exchanger makes it possible to achieve such a degree of heat exchange that the outgoing temperature of the cool flow is higher than the outgoing temperature of the hot flow. This is not possible when using a flow geometry where the media travel in the same direction through the heat exchanger, i.e. so called parallel flow heat exchangers. (Application at page 1, line 8 - page 2, line 10).

To achieve optimum heat transfer in the heat exchanger it is necessary that the heat transfer between each medium and the separating wall is as good as possible. This can be accomplished by designing the separating wall in such a manner that it promotes the generation of a turbulent, well mixed, vortex filled flow in the medium that is in contact with the wall. In the present inventive heat exchanger the flow is arranged so as to be distributed over several parallel passageways in such a way that the passageways are alternately in juxtaposed relationship so there is as large total heat transfer surface area. The heat transfer walls in the inventive heat exchanger contribute to the generation of a turbulent flow with good heat transfer to the wall. Their inventive heat-exchanger uses counter-current flow of the media in the heat exchanger. (Application at page 2, line 11 – 30).

Figure 1 in a perspective view shows important steps of the manufacture of a heat exchanger according to the present invention. Figure 2 is a perspective view of a heat exchanger according to the invention depicted in a not fully closed state in order to show the internal flows of the media. Figure 3 is a perspective view of a part of the heat transferring walls in the same heat exchanger. Figure 4 is a perspective view of a heat exchanger according to the invention in accordance with a slightly different embodiment and shown in a not fully closed state. Figure 5 is a top view of a portion of the heat exchanger. Figure 6 is a top view of the portion of Figure 5 after it has been folded and Figure 7 is a section of Figure 5. (Application at page 3, lines 4 – 15 and Amendment filed October 22, 2004).

A heat exchanger according to the invention preferably is produced from a continuous sheet 1 of metal, plastic or other suitable material, which in the completed heat exchanger will serve as a heat-transferring wall. In Figure 1, reference numbers 2 and 3 denote rollers between which the sheet is fed in the direction of arrow 4. The surfaces of the rollers are formed with

patterns of oblique ridges and grooves 5 and 6. Furthermore, the rollers are formed with ridges 7 and grooves 6 extending parallel with the roller axis. Every ridge 7 corresponds to a groove 8 on the opposite roller. Accordingly, when the sheet passes between the rollers, the ridges 7 and the grooves 8 form folding lines 9 in the sheet. In sequence along the circumference of each roller, a ridge 7 is followed by a groove 8. Accordingly, the folding lines are be pressed alternately in one side and then in the opposite side of the sheet. This makes it easy to fold the sheet at the folding lines into a package 10 comprised by a number of juxtaposed layers. The oblique pattern 5 and 6 on the rollers gives the band a corrugated configuration best visible in the encircled enlargement 11 in Figure 1. The sheet is cut to suitable lengths so that an appropriate thickness of the package 10 is obtained. (Application at page 3, line 16 – page 4, line 1).

In Figure 1, a complete finished package is represented by numeral 12. The ends of the package 12 are closed by covering elements 13. The covering elements may be produced by dipping the package ends into a soft compound that hardens or solidifies when cooled or through a chemical reaction. Reference number 14 is a sealing strip that is applied to one side of the package, e.g. the bottom part. A corresponding seal, not visible in the drawing, is applied to the opposite side of the package. Reference number 15 denotes a box-shaped casing 15 generally, into which the package 12 is intended to be placed as indicated by arrow 16. When the package is placed inside the casing, the seal 14 will be forced against the bottom of the casing and covering elements 13 will seal against the end walls 17 and 18 of the casing. Preferably, the width B of the package 12 essentially corresponds to the spacing between the sidewalls 19 and 20 of the casing while the height H of the package essentially corresponds to the height of the casing. The casing 15 has a lid 21. The shape of the lid matches that of the open upper side of the casing 15. At the corners of the casing 15 connecting ports 22 23, 24 25 are arranged.

The connecting ports 22 and 25 serve as inlet and outlet ports respectively for one medium and connecting ports 23 and 24 serve as inlet and outlet ports respectively for the other medium. When the lid 21 is fitted while the package 12 is in the casing 15 the lid will seal against the top face of the package 12. The sealing strips 14 and the covering elements 13 prevent the two media from mixing and thus the media are kept separate, one on either side of package 12 and thus on either side of the folded sheet. (Application at page 4, lines 1 – 33).

Figure 2 shows the upper part of the package slightly raised to illustrate the flow paths of the two media. The directions of flow are shown by arrows 26 for one medium and by arrows 27 for the other medium. As is most clearly apparent from Figure 3, the corrugations in one layer of the folded sheet extend crosswise with respect to the corrugations in the next layer. These crossing corrugations formed in the facing sides of adjacent layers create a turbulent flow in the medium flowing between the layers. This contributes to an efficient exchange of heat between the two media. (Application at page 4, line 33 – page 5, line 8).

In the example shown the sheet is given a corrugated pattern but within the scope of this invention shaped patterns of different configuration that create turbulence in the inter-layer space may also be used. In the example shown the shaped pattern was made by means of rollers, but the shaped pattern can also be accomplished by stamping. As mentioned above, the covering elements 13 are made of a solidifying compound. However, it is within the scope of the invention to produce the covering elements 13 as separate lids which with an intermediate soft layer that is pressed against the ends of the package. It is also possible to use layers of soft material between the ends of the package and the end walls of the outer casing. The casing 15 and the lid 21 thus form an outer shell that together with the seals 13 and 14 on the package 12 constitutes an efficient media flow separating and sealing means. The seal shown in the figures could however, be made

in a very simple and inexpensive manner. The application of the sealing compound or other soft material can be made without high precision or geometrical exactness. A sealing effect could also be accomplished by a good fit only or by soldering or welding when suitable materials, therefore are used. (Application at page 5, line 9 – 31).

In contrast to the example described above, wherein a casing 15 with a lid 21 forms a shell around the package 12, this shell is formed according to Figure 4 by a box 28 having a rectangular cross sectional shape. On one side, the box is equipped with an inlet port 29 and an outlet port 30 for one of the media and on the other side with an inlet port 31 and an outlet port 32 for the other medium. In this example the package 12 is inserted through one open end of the box which thus forms a casing 33 which may be closed by lids 34 and 35. The lids 34 and 35 are designed to seal against the ends of the package 12, either by themselves or by means of intermediate sealing layers. The lower lid 34 in Figure 4 could for instance be fastened by means of a liquid sealing compound which is poured into the lid and which solidifies after the assembly 28, 12 has been dipped into it. The other lid 35 can then be fastened in the same way after the assembly 28, 12 having been turned upside down. This kind of molding can also be used in the example shown in Figures 1 and 2. When using an appropriate sealing compound the lids may be removed after the molding operation and thus only serve as moulds in the molding process.

The shaped pattern in the sheet serves at least three purposes. One is to establish a certain distance or pitch between successive layers in the folded sheet so that a medium can flow in the inter-layer space. The shaped pattern should also promote turbulence in the flow as described earlier.

The simple pattern described above serves both these purposes. As mentioned above, after folding of the sheet the oblique corrugations form a system of crossing ridges. The ridges maintain a certain spacing between the different folds and produce a tortuous, turbulence inducing flow path for

the medium which, as mentioned above, promotes heat transfer to the wall.

Owing to the design of the heat exchanger, the two media flows are distributed over a number of parallel channels that are placed in alternating nesting position. The third purpose of the shaped pattern is to achieve an evenly distribution of the flow sideways within and across each channel. Thus an essentially counter-current flow pattern is established between the two media flows even when their inlet and outlet ports do not extend in the prolongation of the flow direction. (Application at page 5, line 32 – page 7, line 29).

An efficient lateral spread of the flow of this kind is achieved if the resistance to flow sideways is lower than the resistance of flow lengthwise in the channel. This result is obtained with the proposed simple corrugation of the sheet if the angle of the corrugations to the longitudinal extension of the sheet is less than 45° , or differently expressed, if the angle of the corrugations to the intended direction of flow is more than 45° . (Application at page 7, line 1 – 10).

The simple corrugation pattern which has been used as an example above is easy to produce between two helically cut rollers as in Figure 1. It is also well suited to fulfill the objects of keeping the spacing between the layers, and of promoting turbulence and lateral distribution of the flow as have been discussed above. Many other stamped patterns are also possible, as mentioned above. To facilitate the folding of the sheet the corrugations preferably could be interrupted and be replaced by folding lines at suitable spaced-apart intervals as shown in Figure 1. Another improvement of the pattern would be to provide the inlet and outlet areas (the outer parts of the sheet) with a different pattern from the main part of the sheet area so as to give an efficient lateral distribution of the flow without making the lengthwise resistance to flow too high in the main part of the heat exchanger. A reduction of the resistance to flow in the heat transferring part of the heat exchanger

most often however involves a reduction of the heat transfer there, which is not desirable. (Application at page 7, line 11 - 30).

Figure 5 shows a portion of the heat exchanger with ridges, viewed from above, two ridges marked in red, with a corresponding valley between. On the other side of the fold line, the continuing ridges are shown marked in purple. When folded in the assembled position, as shown in Figure 6, the ridges fold at the points where the red and the purple intersect. The black lines represent regions where the bottom of each valley is farthest from each other. Figure 7 shows a section of Fig. 5, with the ridge peaks shown in red. (Amendment filed October 22, 2004).

VI. Grounds of Rejection to be Reviewed on Appeal

A. Issues

Whether claims 5 and 9 are unpatentable under 35 USC §103(a) as being obvious over SU 800,500 (ACV) in view of GB 1339542 (Usher)? Whether claims 7-8 and 10 -11 are unpatentable under 35 U.S.C. § 103(a) as being obvious over ACV in view of Usher and in further view of US Patent No. 4407357 (Hultgren).

B. Grouping of Claims

Claims 5 and 7-11 are pending in the above application. These claims presently stand rejected, pending appeal.

Claims 5 and 9 were rejected under 35 USC §103(a) as being unpatentable over SU 800,500 (ACV) in view of GB 1339542 (*Usher*).

Claims 7-8 and 10-11 were rejected under 35 U.S.C. § 103(a) as being unpatentable over ACV in view of *Usher* and in further view of US Patent No. 4407357 (*Hultgren*).

Claims 5 and 9 are separately patentably from claims 7-8 and 10-11.

VII. Argument

A. Claims 5 and 9 are Patentable over ACV in view of *Usher*

Independent claims 5 and 9 are recuperative heat exchangers for the exchange of heat across a plurality of heat transferring planar elements between a first fluid medium and a second fluid medium, said fluid mediums flowing in opposite directions to each other on opposite sides of said planar elements. Claim 5 contains numerous limitations, including but not limited to:

- said [corrugated] pattern [on the planar elements] corresponding to a series of alternating ridges and channels extending across the width of each respective planar element formed at an angle of more than 45 degrees with respect to said length of said planar elements, which pattern, in respect to the net flow path, are oriented in a more transverse than lengthwise direction
- said pattern on every other planar element is co-extensive to the other and said ridges and channels between facing sides of adjacent planar elements form a crossing pattern to each other such that said crossing pattern creates a flow resistance to said respective fluid medium flowing over said respective side of said planar element, the ridges and channels being arranged at an angle greater than 45 degrees with respect to a line arranged in a direction along the lengthwise extent so as to present a flow resistance greater in the lengthwise extent direction than the widthwise extent direction, the angle of the ridges and channels tending to increase the overall pressure drop across the heat exchanger compared to smaller angle configurations and force the fluid medium to travel more readily in the widthwise directions before exiting the heat exchanger, the angle of the ridges and channels arranged to force the fluid medium to exhibit a substantially thermally balanced flow distribution across the widthwise extent of the heat exchanger surfaces, thereby increasing flow turbulence and heat transfer.

Claim 9 includes numerous limitations, including but not limited to:

- said flow path has means for creating a flow resistance to said respective mediums such that the flow resistance to said respective mediums flowing over said respective side of said planar elements is greater in said lengthwise direction of said heat transfer package than in said widthwise direction, thereby increasing flow turbulence and heat transfer.

Claims 5 and 9 were rejected under 35 USC §103(a) as obvious over SU 800,500 (ACV) in view of GB 1339543 (*Usher*). Claims 5 and 9 are patentable over ACV in view of *Usher*. First, one skilled in the art would not combine ACV and *Usher*. Second, ACV and/or *Usher* alone or in combination do not teach a heat exchanger with all the elements of claims 5 and 9.

1. One Skilled in the Art would not combine ACV with *Usher*

Claims 5 and 9 include numerous limitations. The limitations of claims 5 include but are not limited to that "the angle of the ridges and channels arranged to force the fluid medium to exhibit a **substantially thermally balanced flow distribution** across the widthwise extent of the heat exchanger surfaces, thereby **increasing flow turbulence** and heat transfer." The limitations of claim 9 include, but are not limited to that "the **flow resistance to said respective mediums flowing over said respective side of said planar elements is greater in said lengthwise direction** of said heat transfer package than in said widthwise direction, thereby **increasing flow turbulence** and heat transfer."

A reference teaches away from the claimed invention when it leads one skilled in the art in the other direction from the claimed modification. *Usher* teaches away from a thermally balanced flow distribution and increased flow turbulence. The flow in *Usher* is changes direction along

the individual sheets comprising the exchanger package, such that the flow pattern from one plate to the next is changed. This results in an uneven flow distribution from plate to plate and reduced turbulence.

The present heat exchanger design and orientation on the other hand requires flow to proceed along the length of each sheet in the same direction, such that the two mediums are proceeding on each side of a sheet in exactly the same manner, thereby balancing the flow distributions and increasing turbulence.

Obviousness cannot be established by combining the teachings of the prior art to produce the claimed invention without some teaching suggestion, motivation or incentive to support the combination. See, e.g. *In re Lee*, 277 F.3d 1338, 1342-43 (Fed. Cir. 2002); *In re Fritch*, 972 F.2d 1260, 1265-67 (Fed. Cir. 1992); and *ACS Hosp. Sys., Inc. v. Montefiori Hosp.*, 732 F.2d 1572, 1577 (Fed. Cir. 1984). Here there is not teaching, suggestion or motivation to combine ACV and *Usher*.

ACV is directed to a nozzle made from paper impregnated with thermoplastic resin. Partial polycondensation of the resin is carried out, a solvent moistens the bending lines, and then complete polycondensation of the resin is carried out. ACV addresses special problems associated with bending paper into a heat exchanger shape and thus discusses the fold lines. There is not teaching or suggestion in ACV related to the angles or pattern of the corrugations. There is no discussion of the flow distribution. *Usher* has unbalanced flow distributions and reduced turbulence.

Because *Usher* teaches away from a balanced flow distribution and increased turbulence, one skilled in the art would not combine *Usher* and ACV to create a heat exchanger with all the limitations of claims 5 and 9 such as a balanced flow distribution and increased flow turbulence. Thus,

claims 5 and 9 were improperly rejected under 35 USC §103(a) as being obvious over ACV and *Usher*.

2. ACV and/or Usher Alone or in Combination Do Not Teach a Heat Exchanger with All the Limitations of Claims 5 and 9.

ACV is directed to a nozzle made from paper impregnated with thermoplastic resin. Partial polycondensation of the resin is carried out, a solvent moistens the bending lines, and then complete polycondensation of the resin is carried out. ACV addresses special problems associated with bending paper into a heat exchanger shape. ACV discusses fold lines. It does not discuss the angles of the corrugations or corrugation pattern. There is no teaching or suggestion in ACV related to the angles or pattern of the corrugations or to the flow distribution.

Usher does not make up the deficiencies in ACV. *Usher* was said to disclose a heat exchanger for two fluids comprising a plurality of rectangular plates, wherein the angle of the ridges and channels are 30 degrees with respect to the width of the plate (i.e. 60 degrees with respect to the length of the plate) for the purpose of improving heat exchange. The flow of *Usher* changes direction along the individual sheets comprising the exchanger package, such that the flow pattern from one plate to the next is changed. This results in an uneven flow distribution from plate to plate and reduced turbulence.

The present heat exchanger design and orientation on the other hand requires flow to proceed along the length of each sheet in the same direction, such that the two mediums are proceeding on each side of a sheet in exactly the same manner, thereby balancing the flow distributions as a means of maximizing heat transfer.

ACV and/or *Usher* alone or in combination do not teach or suggest a continuous heat exchange package element where the pattern is formed

on the entire planar element and which orientates the package such that the flow distribution is balanced on each side of an element due to the flow having a higher flow friction in the lengthwise direction than in the widthwise direction.

Traditional heat exchanger design balances heat transfer with pressure drop. A tortuous fluid flow across a heat transfer surface generates higher heat transfer, but at the same time suffers from increased pressure drops. Heat exchangers with increased pressure drops are less energy efficient, as more energy is required to circulate the heat transfer media. In traditional heat exchanged design it is assumed that all area of heat transfer surfaces provide an equivalent heat transfer. In reality, the flows are not evenly spread on the two sides of the heat transfer surface. The unbalanced flow results in different areas of the heat exchange surface having different surface flows resulting in, for example, greater warm flow in a given area as opposed to a greater cooling flow. Even where an extremely large heat transfer surface is available it cannot be assumed that the two flows will be equivalent. The greater of the flows is never fully changed in temperature where the smaller flow is not be able to supply or absorb a sufficient amount of energy. The local imbalances of the flows adversely influence the total heat transfer of the heat exchanger.

In heat exchange equipment with similar placement of input and output ports as in the present non-obvious invention there will always be a tendency for the flows on each respective side to pass along the shortest distance. This will result in a warm flow concentrating on one side of the bundle and a cool flow concentrating along the opposite side of the bundle. This obviously leads to non-complete heat transfer between two flows.

In the presently cited references, *ACV* and *Usher*, this problem is not acknowledged and/or dealt with. The present non-obvious invention's solution to this problem is to provide the heat exchanger surface in a pattern whereby the resistance to flow is greater along the intended direction of flow than it is in the transverse direction. This results in the flow spreading out in the transverse direction which allows for the lowest overall pressure drop as the flow is utilizing all of the available surface and at the same time the spread out flow maximizing the heat transfer as the hot and cold sides of the heat transfer surface have an even distribution of each respective medium. *ACV* and/or *Usher*, alone or in combination do not teach, suggest or disclose the importance and the means for distributing the flows evenly on both sides of the heat exchanger surface where the input and output ports for a given heat transfer medium is located on the same edge of the heat transfer bundle.

As the prior art fails to teach, suggest or disclose applicant's novel and non-obvious configuration, including but not limited to thermally balanced flow distribution, increased turbulence, and flow resistance that is greater in a lengthwise direction and in a widthwise direction rejection under 35 U.S.C. 103(a) was improper and claims 5 and 9 are patentable.

**B. Claims 7-8 and 10-11 are patentable over
ACV in view of Usher in further view of
Hultgren**

**1. One Skilled In the Art Would Be Led
Away From The Combination of ACV,
Usher and Hultgran**

As discussed above, one skilled in the art would not combine ACV and *Usher*. Further, one skilled in the art would not combine *Hultgran* with ACV and/or *Usher*. Obviousness cannot be established by combining the teachings of prior art to produce the claimed invention, absent some teaching, suggestion or incentive supporting the combination. , e.g. *In re Lee*, 277 F.3d 1338, 1342-43 (Fed. Cir. 2002); *In re Fritch*, 972 F.2d 1260, 1265-67 (Fed. Cir. 1992); and *ACS Hosp. Sys., Inc. v. Montefiori Hosp.*, 732 F.2d 1572, 1577 (Fed. Cir. 1984). Absent a showing in the prior art, the Examiner has impermissibly used "hindsight" occasioned by the applicant's teaching to hunt through the prior art with the claimed elements and combine them as claimed. See, e.g. *In re Fritch*, 972 F.2d 1260, 1265-67 (Fed. Cir. 1992).

Hultgren expressly states that turbulence must not be created. See, e.g. *Hultgren* at column 1, lines 41, 42. Applicant respectfully asserts that the Examiner has improperly combined references where the references teach away from their combination.

The inventive heat exchange package is oriented inside the casing such that the lengthwise direction of each element is exposed to the respective fluid medium. *Hultgren* on the other hand, leaves both end portions of each heat exchange element free of profiles in order to form the inlet/outlet boxes for the flow mediums. In addition, *Hultgren* teaches an angle of inclination of the ridged pattern be 20° or less, preferably around 5°. This low approach angle is instrumental in that exchanger accomplishing its recirculation effect by not reaching turbulent flow.

The present invention on the other hand increases flow turbulence. The orientation of the heat exchange package and the angle of inclination of the corrugated pattern in the present invention causes turbulent flow, where the lengthwise flow component is higher in turbulence and friction than the widthwise component, thereby improving heat exchange.

Hultgren, conversely, claims its non-turbulent design improves heat exchange by recirculation of portions of the flow stream, while the present design improves heat exchange through increasing the travel time in the lengthwise direction by providing a corrugation pattern that promotes additional friction and turbulence in that direction of flow.

As discussed above with respect to claims 5 and 9, it is well known that increased turbulence increases the energy to move the fluid through the exchanger. *Hultgren* goes to great lengths to repeatedly state that its configuration is arranged to avoid turbulence and increased pressure drop. See *Hultgren*, at e.g. column 1 lines 41-43. Further, *Hultgren* teaches a heat exchanger which achieves its desired objects while keeping the angles less than 20 degrees, preferably about 5 degrees.

One skilled in the art would not combine *ACV*, *Usher* and *Hultgren*. Further, *Usher* and *Hultgren* teach away from the present invention. Thus, rejection under 35 USC §103(a) was improper.

2. *ACV*, *Usher* and/or *Hultgren* Alone or in Combination Do Not Teach a Heat Exchanger with All the Limitations of Claims 7-8 and 10-11.

As discussed above *ACV* and/or *Usher* alone or in combination do not teach or suggest a heat exchanger with all the limitations of claims 5 and 9. *Hultgren* does not make up the deficiencies in *ACV* and/or *Usher*. *Hultgren* does not teach or suggest thermally balanced flow distribution, increased flow turbulence nor does it teach or suggest flow resistance that

is greater in the lengthwise direction than the widthwise direction. Thus, claims 7-8 and 10-11 are patentable over *ACV*, *Usher* and *Hultgren*, alone or in combination.

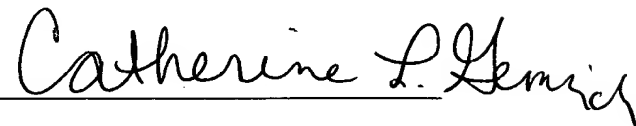
VIII. Conclusion

Claims 5 and 9 are patentable over *ACV* and *Usher*. One skilled in the art would not combine *ACV* and *Usher*. Further, *ACV* and/or *Usher* alone or in combination do not teach or suggest a heat exchanger that includes all the limitations of claims 5 or 9. Thus, claims 5 and 9 are patentable. Claims 7-8 and 10-11 depend directly or indirectly from claim 5 or 9 and thus are patentable.

Claims 7-8 and 10-11 are patentable over *ACV*, *Usher* and *Hultgran*. One skilled in the art would not combine *ACV*, *Usher* and *Hultgran*. Further *ACV*, *Usher* and/or *Hultgran* alone or in combination do not teach or suggest a heat exchanger that includes all the limitations of claims 7-8 and 10-11. Thus, claims 7-8 and 10-11 are patentable.

Respectfully

submitted,



CATHERINE L. GEMRICH
Attorney for Applicant
Registration No. 50,473

DRUM & ROTH LLC
53 W. JACKSON BLVD.
STE 1616
CHICAGO, ILLINOIS 60604
TELEPHONE: 312.922.6262
FACSIMILE: 312.922.7747

X. Appendix

A. CLAIMS

5. A recuperative heat exchanger for the exchange of heat across a plurality of heat transferring planar elements between a first fluid medium and a second fluid medium, said fluid mediums flowing in opposite directions to each other on opposite sides of said planar elements, said heat exchanger comprising:

a casing for containing a heat transfer package therein, said casing having a top end, a bottom end, a pair of respective lengthwise and widthwise opposed sides, each of said lengthwise sides provided with a pair of inlet and outlet ports, wherein each respective pair of inlet and outlet ports is dedicated to one of said first and second mediums for flow therethrough;

a heat transfer package disposed within said casing, said heat exchange package having a lengthwise extent and a widthwise extent, each of the fluid mediums following on their respective side of the planar elements a net flow path which extends longitudinally along the lengthwise extent, said package comprised of a plurality of generally rectangularly shaped planar elements continuously arranged in sequentially alternating directions in a folded accordion-like manner, each of said planar elements having substantially similar length, width and thickness with respect to each other, each of said planar elements integrally connected to an adjacent planar element along said length, said length and width of said casing substantially corresponding to said length and width of said package, opposing surfaces from each adjacent planar element defining an inter-layer space therebetween for receiving a flow of one of said fluid mediums therebetween, a direction of flow of each medium having a widthwise element and a lengthwise element when flowing within said inter-layer space, each of said planar elements having a corrugated pattern formed therein, said corrugated pattern extending the entire length and width of each respective planar element, said pattern corresponding to a series of alternating ridges and channels extending across the width of each respective planar element formed at an angle of more than 45 degrees with respect to said length of said planar elements, which pattern, in respect to the net flow path, are oriented in a more transverse than lengthwise direction, said corrugated pattern interrupted at substantially similar intervals to include a fold line for facilitating arranging each of said planar elements in an accordion-like manner, said fold lines defining said width of each respective element and being disposed parallel along said length of each of said elements, wherein when said heat transfer package is in an unfolded state, a

pattern of ridges and channels of a first planar element is generally aligned with respect to a pattern of channels and ridges of a successive planar element, and

wherein when said heat transfer package is in a folded state, said pattern on every other planar element is co-extensive to the other and said ridges and channels between facing sides of adjacent planar elements form a crossing pattern to each other such that said crossing pattern creates a flow resistance to said respective fluid medium flowing over said respective side of said planar element, the ridges and channels being arranged at an angle greater than 45 degrees with respect to a line arranged in a direction along the lengthwise extent so as to present a flow resistance greater in the lengthwise extent direction than the widthwise extent direction, the angle of the ridges and channels tending to increase the overall pressure drop across the heat exchanger compared to smaller angle configurations and force the fluid medium to travel more readily in the widthwise directions before exiting the heat exchanger, the angle of the ridges and channels arranged to force the fluid medium to exhibit a substantially thermally balanced flow distribution across the widthwise extent of the heat exchanger surfaces, thereby increasing flow turbulence and heat transfer.

7. A recuperative heat exchanger as claimed in claim 5 wherein:
said casing is sealed at said top and bottom ends by covering elements.

8. A recuperative heat exchanger as claimed in claim 7 wherein:
said covering elements are formed from a compound which solidifies upon cooling or by chemical reaction.

9. A recuperative heat exchanger for the exchange of heat across a plurality of heat transferring planar elements between a first fluid medium and a second fluid medium, said fluid mediums flowing in opposite directions to each other on opposite sides of said planar elements, said heat exchanger comprising:

a casing for containing a heat transfer package therein, said casing having a top end, a bottom end, a pair of respective lengthwise and widthwise opposed sides, each of said lengthwise sides provided with a pair of inlet and outlet ports, wherein each respective pair of inlet and outlet ports is dedicated to one of said first and second mediums for flow therethrough;

a heat transfer package disposed within said casing, said heat exchange package having a lengthwise extent and a widthwise extent, each of the fluid mediums following on their respective side of the planar elements a net flow path which extends longitudinally along the lengthwise extent, said package comprised of

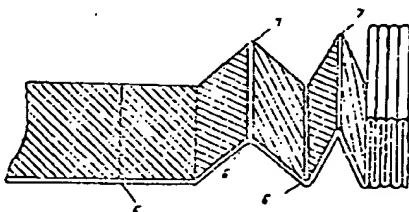
a plurality of generally rectangularly shaped planar elements continuously arranged in sequentially alternating directions in a folded accordion-like manner, each of said planar elements having substantially similar length, width and thickness with respect to each other, each of said planar elements integrally connected to an adjacent planar element along said length, said length and width of said casing substantially corresponding to said length and width of said package, opposing surfaces from each adjacent planar element defining an inter-layer space therebetween for receiving a flow of one of said fluid mediums therebetween, a direction of flow of each medium having a widthwise element and a lengthwise element when flowing within said inter-layer space, each of said planar elements having a corrugated pattern formed therein;

said corrugated pattern extending the entire length and width of each respective planar element, said pattern corresponding to a series of alternating linear ridges and channels extending across the entire width of each respective planar element, said corrugated pattern interrupted at substantially similar intervals to include a fold line for facilitating arranging each of said planar elements in an accordion-like manner, said fold lines defining said width of each respective element and being disposed parallel of said length of each of said elements, wherein when said heat transfer package is in an unfolded state, a pair of ridges and channels of a first planar element is generally aligned with respect to a pattern of channels and ridges of a successive planar element, and

whereby said flow path has means for creating a flow resistance to said respective mediums such that the flow resistance to said respective mediums flowing over said respective side of said planar elements is greater in said lengthwise direction of said heat transfer package than in said widthwise direction, thereby increasing flow turbulence and heat transfer.

10. A recuperative heat exchanger as claimed in claim 9 wherein: said casing is sealed at said top and bottom ends by covering elements.

11. A recuperative heat exchanger as claimed in claim 10 wherein: said covering elements are formed from a compound which solidifies by cooling or by chemical reaction.

79230 D/43 AIR COND VENTIL 03.10.78-SU-694235 (10.02.81) F241-03/08 F28d-09 Air conditioning system heat utiliser - has checker in form of concertina of zigzag paper strip impregnated with thermoplastic resins	A88 J08 Q74 Q78 AIRC= 03.10.78 *SU-800-500 A(12-B3, 12-H, 12-R2) J(7-A7)
03.10.78 as 694235 (18MI) The heat utiliser comprises a body with inlets and outlets containing a checker. For efficient heat utilisation, the checker (6) is in the form of a concertina of zigzag-folded paper strip impregnated with thermoplastic resins. The bend lines (7) are directed towards the inlets and outlets. This made made by putting the checker in the body. The paper strip as described above it made by partial polycondensation of the resins, impregnated with solvent on cross-lines and then bent on these lines to form the concertina. The resins are then fully condensed. Bul.4/30.1.81. (3pp Dwg.No.2)	482 



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СССР
по делам изобретений
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(72) Авторы
изобретения

И.Р.Щекин, Б.И.Бялый, В.А.Динцин, А.В.Степанов, Ф.А.Набиулин,
Н.В.Наришный, И.Л.Розенштейн и В.И.Владимиров

(71) Заявитель

Всесоюзный научно-исследовательский и проектно-
конструкторский институт по оборудованию для
кондиционирования воздуха и вентиляции

(54) УТИЛИЗАТОР ТЕПЛА И СПОСОБ ЕГО ИЗГОТОВЛЕНИЯ

1

Изобретение относится к технике кондиционирования воздуха, конкретно, к утилизации тепла.

Известны утилизаторы тепла преимущественно для систем кондиционирования воздуха, содержащие корпус с подводящими и отводящими патрубками и размещенную внутри него насадку [1].

Недостатками известного устройства утилизатора являются недостаточно высокая интенсивность процесса утилизации тепла и невозможность утилизации влаги.

Цель изобретения - повышение эффективности утилизации тепла.

Цель достигается тем, что насадка выполнена в виде гармошки из кософфрированной бумажной ленты, пропитанной термопластичными смолами, причем линии сгибов гармошки направлены в сторону подводящих и отводящих патрубков.

Утилизатор может быть изготовлен новым способом, заключающимся в том, что в качестве насадки выбирают бумажную ленту, пропитанную термопластичными смолами, осуществляют частичную поликонденсацию смол, смачивают ее растворителем по попереч-

2

ным линиям, затем по этим линиям ленту сгибают в виде гармошки, после чего производят полную поликонденсацию смол.

5 На фиг. 1 изображен предлагаемый утилизатор тепла; на фиг. 2 - насадка.

10 Утилизатор содержит корпус 1 с подводящими 2 и отводящими 3 патрубками удаляемого воздуха, и подводящими 4 и отводящими 5 патрубками наружного воздуха. Внутри корпуса 1 размещена насадка 6 в виде гармошки из кософфрированной бумажной ленты, пропитанной термопластичными смолами, причем линии 7 сгибов гармошки направлены в сторону подводящих и отводящих патрубков.

15 Устройство работает следующим образом.

20 Для сохранения жесткости гофр термопластичные смолы в бумажной ленте должны быть полностью поликонденсированы, но из-за хрупкости бумажной ленты сгибание в гармошку невозможно. Чтобы избежать поломки ленты при ее сгибании в гармошку и при этом сохранить форму гофр, гофрируют бумажную ленту с одновре-

30 менной частичной конденсацией про-

питывающих ее термопластичных смол. Линии 7 сгибов ленты смачивают растворителем пропитывающих ее термопластичных смол. При этом смолы на линии сгибов растворяются и тем самым бумажная лента по этим линиям становится пластичной; по линиям 7 сгибов производят сгибание косо-гофрированной бумажной ленты в гармошку, образуя насадку, после чего производят термообработку насадки в сборе до полной поликонденсации пропитывающих бумагу смол.

Насадку вставляют в корпус 1 без зазора с его боковыми стенками линиями 7 сгибов ленты, направленными в сторону подводящих 2 и 4 и отводящих 3 и 5 патрубков удаляемого и наружного воздуха. При этом для потока воздуха образуются полости из перекрещивающихся каналов, замкнутых боковыми стенками корпуса 1, линиями 7 сгибов из косо-гофрированной бумажной ленты, открытыми в сторону подводящих и отводящих патрубков.

Удаляемый воздух через подводящий патрубок 2 поступает в насадку 6-и, пройдя полости, образованные перекрещивающимися каналами, выбрасывается через отводящий патрубок 3. Наружный воздух проходит аналогичный путь через патрубки 4 и 5, но по смежным полостям насадки 6, разграниченным пластинами косо-гофрированной ленты.

При одновременном прохождении удаляемого и наружного потоков воздуха через пластины косо-гофрированной бумажной ленты за счет ее теплопроводности и гигроскопичности происходит передача тепла и влаги от одного потока к другому. Передача тепла и влаги интенсифицируется за счет выполнения полостей

для прохода воздуха из перекрещивающихся каналов бумажной гофрированной ленты, в которых потоки воздуха постоянно закручиваются.

Использование предлагаемого устройства дает положительный эффект, заключающийся в интенсификации процесса утилизации тепла, а также в утилизации влаги.

10

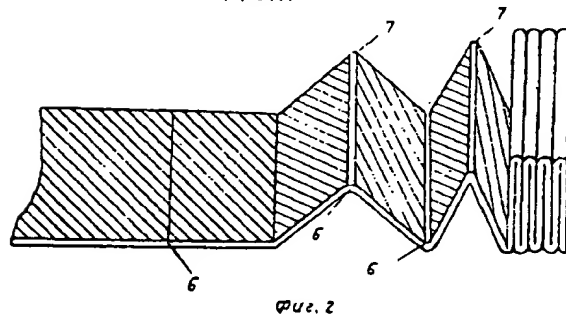
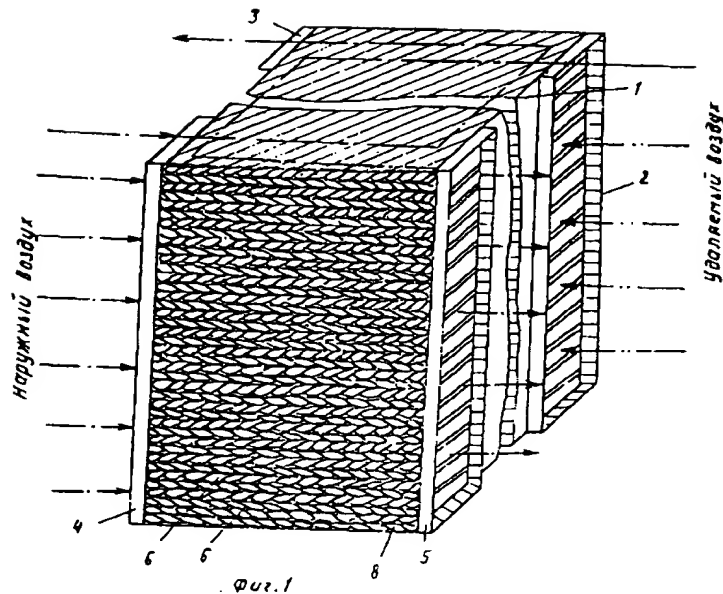
Формула изобретения

1. Утилизатор тепла, преимущественно для системы кондиционирования воздуха, содержащий корпус с подводящими и отводящими патрубками и размещенную внутри него насадку, отличающаяся тем, что, с целью повышения эффективности утилизации тепла, насадка выполнена в виде гармошки из косо-гофрированной бумажной ленты, пропитанной термопластичными смолами, причем линии сгибов гармошки направлены в сторону подводящих и отводящих патрубков.

2. Способ изготовления утилизатора тепла по п. 1 путем размещения насадки в корпусе утилизатора, отличающийся тем, что в качестве насадки выбирают бумажную ленту, пропитанную термопластичными смолами, осуществляют частичную поликонденсацию смол, смачивают ее растворителем по поперечным линиям, затем по этим линиям сгибают в виде гармошки, после чего производят полную поликонденсацию смол.

Источники информации, принятые во внимание при экспертизе

1. "Heat recovery in air systems". - "Heat and Ventilating Engineer", Великобритания, 50, № 593, 1977, с. 10-14.



Редактор А.Власенко	Составитель В.Подносова	
Заказ 10372/41	Техред Т.Маточка	Корректор Н.Григорук
	Тираж 835	Подписное
ВНИИП. Государственного комитета СССР по делам изобретений и открытий		
113035, Москва, Ж-35, Раушская наб., д. 4/5		
Филиал ППП "Патент", г. Ужгород, ул. Проектная, 4		

SPECIFICATION OF INVENTION
TO INVENTOR'S CERTIFICATE

(11) 800500

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(72) Inventors	I.R. Schekin, B.I. Byaly, V.A. Dintsin, A.V. Stepanov, F.A. Nabiulin,		
(71) Applicant	N.V. Narishny, I.L. Rozenshtein and V.I. Vladimirov		
	All-Union Scientific-Research and Design Institute of		
	Air-Conditioning and Ventilation Equipment		

(54) HEAT RECOVERY APPARATUS AND METHOD
FOR PRODUCTION THEREOF

The invention relates to the field of air conditioning, concretely, to heat recovery.

Heat recovery apparatuses are known for primarily air conditioning systems, the apparatuses comprises a body with inlet and outlet pipes and a nozzle inside it [1].

Drawbacks of the known recovery apparatus are insufficiently high intensity of the heat recovery process and the fact that it is not possible to recover moisture.

The object of the invention is to enhance the effectiveness of heat recovery.

The object is achieved in that a nozzle is made in the form of an accordion-like bellows of skewed corrugated paper band impregnated with thermoplastic resins, wherein the crease lines of the bellows are directed toward the inlet and outlet pipes.

The recovery apparatus may be made by a new method consisting in that a paper band impregnated with thermoplastic resins is used as the nozzle, partial polycondensation of the resin is carried out, it is moistened with solvents along transverse lines, then the band is bent in the form of an accordion-like bellows along those lines, after which complete polycondensation of the resin is carried out.

Fig. 1 shows the proposed heat recovery apparatus, Fig. 2 shows the nozzle.

The recovery apparatus comprises a body 1 with inlet pipes 2 and outlet pipes 3 for the air to be removed, and inlet pipes 4 and outlet pipes 5 for outside air. A nozzle 6 in the

form of an accordion-like bellows of skewed corrugated paper band impregnated with thermoplastic resins is placed inside the body 1. Wherein crease lines 7 of the bellows are directed towards the inlet and outlet pipes.

The apparatus operates in the following manner.

In order to maintain rigidity of the corrugations, the thermoplastic resins in the paper band should be completely polycondensed, but due to the fragility of the paper band it is not possible to bend it into an accordion-like bellows. In order to avoid breaks in the band when it is being bent into the accordion-like bellows and at the same time retain the shape of the corrugations, the paper band is corrugated while simultaneously partially condensing the thermoplastic resins impregnating it. The crease lines 7 of the band are moistened with a solvent of the thermoplastic resins impregnating it. Wherein the resins on the crease lines are dissolved and thus the paper band along these lines becomes plastic, the skewed corrugated paper band is bent along the crease lines 7 into an accordion-like bellows, forming a nozzle, after which the nozzle assembly is subjected to heat treatment to complete polycondensation of the resins impregnating the paper.

The nozzle is put in the body 1 without clearance with its side walls, the crease lines 7 of the band directed toward the inlet 2 and 4 and the outlet 3 and 5 pipes for the air to be removed and the outside air. Wherein, cavities for the flow of air are formed from intersecting channels, closed by the side walls of the body 1, by the crease lines 7 of the skewed corrugated paper band, open towards the inlet and outlet pipes.

The air to be removed through the inlet pipe 2 enters the nozzle 6 and, passing through the cavities formed by the intersecting channels, is discharged through the outlet pipe 3. The outside air passes similarly through the pipes 4 and 5, but through adjacent cavities of the nozzle 6, limited by the plates of the skewed corrugated band.

When there is the simultaneous passage of flows of the air to be removed and the outside air through the plates of the skewed corrugated paper band, heat and moisture are transferred from one flow to the other as a result of the thermal conductivity and hygroscopicity of the paper band. The transfer of heat and moisture is intensified due to making the cavities for the passage of air from intersecting channels of the corrugated paper band, in which channels the air flows are constantly twisting.

Use of the proposed apparatus provides a positive effect, which is intensification of the process of heat recovery, and also moisture recovery.

SET OF CLAIMS

1. A heat recovery apparatus, primarily for an air conditioning system, the apparatus comprising a body with inlet and outlet pipes and a nozzle placed inside the body, characterized in that in order to enhance the effectiveness of heat recovery, the nozzle is made in form of an accordion-like bellows from a skewed corrugated paper band, impregnated with thermoplastic resins, wherein the crease lines of the bellows are directed towards the inlet and outlet pipes.

2. A method for production of a heat recovery apparatus according to claim 1 by placing a nozzle in a body of a recovery apparatus, characterized in that, a paper band impregnated with thermoplastic resins is selected as the nozzle, partial polycondensation of the resins is carried out, it is moistened with a solvent along transverse lines, then bent along those lines in the form of an accordion-like bellows, after which complete polycondensation of the resins is effected.

Sources of Information

taken into account during the examination

1. "Heat recovery in air systems" - "Heat and Ventilating Engineer," Great Britain, 50, No. 593, 1977, pp. 10-14.

1973

PATENT SPECIFICATION

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 B3Q 2A11 2A5 2A6 2Q
 (72) Inventor JOHN DENNIS USHER



F
 GREAT BRITAIN
 GROUP... 3.42
 CLASS... 1.65
 RECORDED

(54) IMPROVEMENTS IN OR RELATING TO PLATE HEAT EXCHANGERS

(71) We, THE A.P.V. COMPANY LIMITED, a British Company, of Manor Royal, Crawley, Sussex, England, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to plate heat exchangers.

A plate heat exchanger, as the term is generally understood, comprises a pack of separable generally rectangular plates arranged in spaced face-to-face relationship. A port, which is normally circular, is arranged adjacent each corner of each plate. Corresponding ports are aligned through the pack of plates, and the aligned ports constitute inlet and outlet ducts for each of two, usually liquid, heat exchange media which flow through alternate flow spaces defined between adjacent plates. Gaskets are arranged in or on the plates to define the flow spaces and to control the flow of media to them and to prevent leakage of the media. In use, the pack of plates is clamped together. Normally, flow of one liquid medium takes place from one of the bottom corner ports to one of the top corner ports of alternate flow spaces, while flow of the other liquid medium takes place downwards from the other of the top corner ports to the other of the bottom corner ports in the adjacent or intervening flow spaces. Because of the difference of the gasketing in each of the two types of plate, they are referred to as being of opposite hands, i.e. left hand and right-hand.

If the temperature rise of one medium is θ and the log mean temperature difference measured across the plate between the two liquid media is ΔT , then the thermal performance of the plate can be expressed as the ratio:

[Price 25p]

$$\frac{\theta}{\Delta T}$$

which is known as the temperature ratio (T.R.) of the plate. 45

The specification of the magnitude of this ratio represents quantitatively the thermal duty to be performed by the heat exchanger, while the temperature ratio which can in practice be achieved by any particular plate is given by the following relationship:— 50

$$\frac{2UA}{qC}$$

where

- U = the overall heat transfer coefficient 55
 A = the developed heat transfer surface area of the plate
 q = the mass flow rate of either liquid medium across the plate
 C = the specific heat of this liquid medium. 60

It will therefore be seen that the higher the heat transfer coefficient for any particular liquid the higher will be the temperature ratio which the plate can achieve.

One important factor in determining the magnitude of the heat transfer coefficient of a plate is the type of corrugation (trough form) or protuberance which is pressed into the plate, as this determines the amount of turbulence generated in the liquid medium, the generation of turbulence having as its object an increase in the heat transfer. The highest temperature ratio will be obtained at the minimum liquid flow rate at which the flow space will properly fill with liquid, while the minimum temperature ratio is given by the maximum liquid flow rate which can be achieved before the pressure loss across the flow space becomes excessive. The ratio of 75

the maximum to minimum temperature ratios corresponding to these two extreme conditions is relatively low (about 1.5:1 to 2:1) so that one plate design cannot be used over a wide range of temperature ratios corresponding with a wide range of thermal duties.

It is therefore necessary to provide plates with a number of different trough forms or shape of protuberance, each with its own values of heat transfer coefficient and therefore of temperature ratio. However, because the plate is an extremely complex pressing the tools for its manufacture are correspondingly expensive and to have one set of press tools for each range of temperature ratios required is uneconomic.

It is an object of the invention to provide a heat exchanger plate which can be produced in a variety of forms without the need for a complete set of press tools for each form.

According to the invention, a heat exchanger plate of the ported and gasketed type comprises a flow space area comprising end zones i.e. zones adjacent a fluid inlet and outlet respectively and a principal heat exchange area, at least the heat exchange area being formed with corrugations or other turbulence inducing formations, the said heat exchange area being formed as a plurality of discrete zones each having a pattern of corrugations or other formations thereon, at least one of the said discrete zones having a pattern which differs in respect of the turbulence inducing characteristics of the corrugations or other formations from that of at least one other zone, whereby the heat transfer characteristics of the zones of the plate differ between the said one discrete zone and the said discrete zone.

The zones will normally be divided into two groups; namely those with a pattern leading to a high temperature ratio, and those with a pattern leading to a low temperature ratio. The choice of the relative number of zones in said groups will be dictated by the duty to be performed.

A set of press tools for manufacturing plates of a variety of performances could thus consist of common parts for pressing the end areas including the ports and the zones connecting the ports with the main flow space area. There would also be two (or more if required) sets of partial tools for pressing the pattern for corrugations or other formations on the zones of the main flow space area. The invention also consists in a set of tools for pressing a range of heat exchanger plates having a flow space area comprising end zones, and a principal heat exchange area formed as a plurality of discrete zones each having a pattern of corrugations or other turbulence inducing formations, comprising common parts for pressing end areas of the plates including the said end zones, and two or

more sets of partial tools for pressing the patterns of corrugations or other formations as the said discrete zones of the flow space area, the said sets being adapted to press patterns which differ in respect of the turbulence inducing characteristics of the corrugations or other formations, and also being interchangeable whereby plates may be pressed with either a complete set or with a composite set of partial tools made up from more than one of said sets.

The plates could be divided into zones along generally transverse (horizontal) lines, which may be straight or, preferably, broken to avoid lines of weakness across the plate. The breaking of the line could be achieved by introducing undulations therealong. Division along longitudinal (vertical) lines, straight or broken, is also possible.

The invention still further consists in a plate heat exchanger comprising a pack of plates with at least some of the plates arranged in spaced face-to-face relationship, with at least some of the plates being according to the invention as set forth above.

The invention will be further described with reference to the diagrammatic drawings accompanying the Provisional Specification and the accompanying diagrammatic drawings:

In the drawings accompanying the Provisional Specification:

Figures 1 and 2 are elevations of the plates of one type of conventional plate pair;

Figures 3 and 4 and Figures 5 and 6 are each elevations of the plates of two basic forms of pair from which the plates according to the invention are derived;

Figures 7 and 8 are elevations of the plates of one type of plate pair, incorporating the invention;

Figures 9 and 10 show a variation of Figures 3 and 4;

Figure 11 is an elevation of a further form of plate according to the invention;

Figures 12 and 13 are alternative partial longitudinal sections of Figure 11;

Figure 14 is a longitudinal section of a further form of plate according to the invention;

Figure 15 is an elevation of the plate of Figure 14;

Figures 16 and 17 show further possible variations of Figure 3;

Figures 18 and 19 are exploded side and end elevations of a pair of bolsters for a tool for pressing various types of plates according to the invention.

Figure 20 is a plan view of one bolster with the press tools in position; and

Figure 21 is a transverse section through the bolster and one press tool.

In the accompanying drawings:

Figures 22 and 23 are elevations of the

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plates of another type of plate pair incorporating the invention; and

Figures 24 and 25 are elevations of a still further form of plate pair incorporating the invention.

A well-known form of plate design on which plate heat exchangers are based includes a flow space area with a series of parallel troughs 1 (see Figures 1 and 2) which are pressed into the plate and inclined at an angle to the vertical (longitudinal) axis of the plate. The adjacent plate has similar troughs 2 inclined at the same angle to the vertical axis but in the opposite direction. The two hands of the plate are illustrated in Figures 1 and 2, where Figure 1 shows the right hand and Figure 2 the left hand plate.

When the adjacent plates are clamped together the troughs run across one another so that contact occurs where the line of the top of one trough intersects the line of the bottom of the other trough, and by this means correct spacing between the plates is maintained.

The same principle of mutual support is achieved if the heat exchange area of flow space of the plate is divided up laterally into a number of horizontal bands 3, in which the angle of the trough with respect to the horizontal is reversed in each alternate band (see Figures 3 and 4). The angle between the troughs and the horizontal (i.e. the lateral direction of the plate) in such a plate could well be about 30° as this angle is found to give a relative high value of the temperature ratio. It is known that as an angle between the trough and the lateral direction (horizontal) is increased, the value of the temperature ratio decreases so that a plate with troughs at an angle of 60° (as illustrated in Figures 5 and 6) to the horizontal, for example would give a much lower temperature ratio than the plate already described. To achieve intermediate temperature ratios it would be necessary to have a trough angle of, for example, 45° and this would necessitate another set of press tools to produce this angle which would represent an undesirable item of capital expenditure.

It will be observed that each of the high temperature ratio plates illustrated in Figures 3 and 4 has five horizontal bands of 30° angle; these bands being designated 'A'. Likewise, it will be observed that the low temperature plates illustrated in Figures 5 and 6 have five horizontal bands of 60° angle; these bands being designated 'B'.

It will be clear that a plate of a temperature ratio performance somewhere between that represented by the high temperature ratio plate embodying five 'A' bands and that separated by the low temperature ratio plate embodying five 'B' bands can be made up by a plate which consists of a mixture of 'A' bands and 'B' bands.

It will be seen that the plate of Figures 3 to 6, and also those of Figures 7 to 17 and 22 to 25, all have triangular zones at the ends of the flow space zone which are primarily distribution zones, although there is necessarily some heat exchange in these zones.

Another method of altering the heat transfer performance is by adjusting the pitch of the corrugations either alone or in combination with a change in angle.

A pair of plates illustrated in Figures 7 and 8 illustrate a trough pattern which consists of two 'B' bands and three 'A' bands. Any combination of 'A' and 'B' bands within the total number of five could be chosen according to the order of the temperature ratio (T.R.) required. There is, of course, no reason why the total number of bands should be limited to five it could be larger or smaller; the larger the number of bands the greater is the degree of flexibility in terms of temperature ratio which can be achieved, but the greater the number of press tool parts required.

For further variation in the temperature ratio of the plate one or other of the A or B bands could be substituted by a third band of a different trough angle and this could be repeated if necessary on additional bands. Another variant would be to make two or more bands into a single unit which in certain circumstances might simplify the tool making problem. It must be appreciated though that the more of these single unit bands that are made the fewer are the number of basic A and B bands that can be utilised from the original tool to give an alternative value of temperature ratio.

The press tool for the plates of Figures 3 to 8 would be constructed in such a way that the sections of the tool corresponding to the 'A' and 'B' bands were interchangeable so that a single composite tool could produce plates with these various trough combinations according to the temperature ratio requirements.

It will be observed that the gasket arrangement in the plates illustrated in Figures 7 and 8 is such that the flow takes place between ports located in diagonally opposite corners of the plate. An alternative arrangement is one in which the flows is more nearly parallel to the side of the plate and runs between the two ports adjacent to a side of the plate. This arrangement has the advantage that by inverting the plate through 180° in a vertical plane it provides a plate of the opposite hand so that only one set of press tools to form the trough is required to produce both hands of the plate.

It will be observed that in the plates illustrated in Figures 7 and 8 the types of bands are arranged in the same sequence. This means that when two plates are clamped together A bands are opposite A bands and B bands opposite B bands and there will be

five changes in flow passage along the plate. It is possible to assemble the bands in a different order for the plates in Figure 8 from that of the plate of Figure 7, and by substitution of an A band by a B band in Figure 8 re-arrangement of the resulting three bands and two A bands would give a flow passage in which each A band of either plate is opposed by B and in the adjacent plate so that a common flow passage would be achieved along the plate.

If this plate is fitted with an even number of trough bands this arrangement has the advantage that by inverting the plate through 180° in a vertical plane it provides a plate of the opposite hand by giving both alternate port positions and troughs which cross over one another on adjacent plates.

In the case of inversion of the trough pattern, the sequence of the band determines the nature of the flow passage. A sequence of A B A B has as its inversion B A B A so that in all parts of the plate A and B bands are opposed and a common flow passage results. A sequence A B B A when inverted will give A B B A so that the flow passage at the end of the plate will be different from that at the middle. A sequence A A A B with its inversion B A A A will give a further variant.

Figures 9 and 10 illustrate a right and left hand plate based on this principle with four horizontal bands and it will be seen that the trough pattern of Figure 9 when inverted becomes the trough pattern of Figure 10. Hence the principle of the two types of band 'A' and 'B' with the combination of bands in the manner already referred to, will enable a number of plates of varying temperature ratios to be produced but instead of having one set of trough pressing tools for each hand of plate of a single set of tools having replaceable sections corresponding to 'A' and 'B' will enable both hands to be manufactured.

Figures 24 and 25 illustrate the use of non-handed plates with A B A B and B A B A configurations.

It will be appreciated that in a sample and practicable case, the number of zones in a plate may be two, one of type 'A' and the other of type 'B'. These could be arranged so that alternate plates were essentially inverted so that 'A' and 'B' cooperate throughout a pack of plates.

It is possible to apply the principle of interchangeable bands or sections to other forms of troughs besides the oblique type which has so far been illustrated. Another common form of trough runs transversely across the plate at right angles to the vertical axis and intermates with the trough of the adjacent plate. The depth of the trough may be greater than the pitch of the plates. In this case the heat transfer coefficient depends on the pitch and angle of the trough and a

plate of this type is illustrated in Figure 11, where it is shown divided into four bands 'A', 'B', 'A', 'B', in which the variation between the trough shown in each type of band would be either the depth, as shown in Figure 12, or the pitch, as shown in Figure 13, or could be both.

Another turbulence promoting plate formation consists of a number of dimples 5, usually circular, which are pressed into the plate as shown in Figure 14. The heat transfer coefficient depends on the pitch and size of the dimples 5, and the 'A' band could, for example, consist of small diameter closely pitched dimples while the 'B' band could consist of large diameter widely pitched dimples so that plate consisting of either 'A' bands or 'B' bands or a combination of the two as shown in Figure 15 could be produced to give a varying range of temperature ratios.

This principle could be applied to other forms of turbulence promoting formations used in plate heat exchangers.

Referring once again to the construction shown in Figures 3 to 10 and 24 and 25 it will be observed that the horizontal line coinciding with the junction between any two bands represents a plane of weakness with respect to horizontal bending of the plate. This can be avoided if this line is broke by the overlapping or intermating of two adjacent bands, two examples being shown in Figures 16 and 17. In Figure 16, the bands meet on an undulating line 6, while in Figure 17 the bands meet on a castellated or square wave form undulating line 7.

Figures 18 to 21 illustrate a form of tooling which may be employed for producing the types of plates shown in Figures 3 to 8.

The tool consists of two opposed bolsters 10 and 11 each having a recess 12 for receiving a set of tool sections. As illustrated, the set of tool sections comprises two end sections 13 and five main sections. Of the two are sections 14 with steeply inclined corrugations and the other three sections have less steeply inclined corrugations. The sections 14 and 15 are interchangeable and any selection of them may be used where a large number of variations in the plate may be achieved. The number is not necessarily limited to five, but any suitable number of sections may be chosen.

The foregoing system which has been confined to bands which divide the plate horizontally can also be applied to bands which divide the plate vertically, as shown in Figures 22 and 23, or a combination of the systems whereby the plates are divided horizontally and vertically into a number of tangential elements which provide interchangeable sections of the press tool to give maximum flexibility and variation in the temperature ratio of the plate. The general

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vertical bounding lines of the bands can be straight as illustrated in Figures 22 and 23, or they may be undulated or castellated as described with reference to Figures 16 and 17.

WHAT WE CLAIM IS:—

1. A heat exchanger plate of the ported and gasketed type comprising a flow space area comprising end zones i.e. zones adjacent a fluid inlet and outlet respectively and a principal heat exchange area, at least the principle heat exchange area being formed with corrugations or other turbulence inducing formations, the said heat exchange area being formed as a plurality of discrete zones each having a pattern of corrugations or other formations thereon, at least one of the said discrete zones having a pattern which differs in respect of the turbulence inducing characteristics of the corrugations or other formations from that of at least one other zone, whereby the heat transfer characteristics of the zones of the plate differ between the said one discrete zone and the said other discrete zone.
2. A heat exchanger plate as claimed in claim 1, in which the discrete zones are in two groups, with the zones of one group having a pattern tending to higher temperature ratio characteristics (as hereinbefore defined) than the pattern of the plates in the other group.
3. A heat exchanger plate as claimed in claim 1 or 2, in which the said discrete zones have corrugations inclined to the general direction of flow, with the variation of heat transfer characteristics being achieved by difference in the angle of inclination, and/or in the pitch of the corrugations.
4. A heat exchanger plate as claimed in any of claims 1 to 3, and in which the number of the said discrete zones is even and the sequence of the zones is selected so that when alternating with an adjacent inverted plate a particular form of flow passage is achieved.
5. A heat exchanger plate as claimed in claim 1 or 2, in which the said discrete zones have transverse corrugations and the variation in heat transfer characteristics is obtained by varying the depth and/or pitch of the corrugations.
6. A heat exchanger plate as claimed in claim 1 or 2, in which the said discrete zones

have turbulence promoting dimples, and in which the variation in heat transfer characteristics is achieved by variation in the size and/or spacing the dimples.

7. A heat exchanger plate as claimed in any of claims 1 to 6, in which the boundary line between adjacent ones of the said discrete zones is straight.

8. A heat exchanger plate as claimed in any of claims 1 to 6, in which the boundary line between adjacent ones of the said discrete zones is undulating.

9. A set of tools for pressing a range of heat exchanger plates having a flow space area comprising end zones, i.e. zones adjacent a fluid inlet and outlet respectively and a principal heat exchange area formed as a plurality of discrete zones each having a pattern of corrugations or other turbulence inducing formations, comprising common parts for pressing end areas of the plates including the said end zones, and two or more sets of partial tools for pressing the patterns of corrugations or other formations on the said discrete zones of the flow space area, the said sets being adapted to press patterns which differ in respect of the turbulence inducing characteristics of the corrugations or other formations and also being interchangeable whereby plates may be pressed with either a complete set or with a composite set of partial tools made up from more than one of the said sets.

10. A heat exchanger plate pressed from a set of tools as claimed in claim 9.

11. A heat exchanger comprising a pack of plates arranged in spaced face-to-face relationship, in which at least some of the plates are plates as claimed in any of claims 1 to 8 or 10.

12. A heat exchanger plate substantially as hereinbefore described with reference to any of Figures 5 to 17 of the drawings accompanying the Provisional Specification.

13. A heat exchanger plate substantially as hereinbefore described with reference to any of the Figures of the accompanying drawings.

14. A set of tools for pressing heat exchanger plates substantially as hereinbefore described with reference to Figures 18 to 21 of the drawings accompanying the Provisional Specification.

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1339542 PROVISIONAL SPECIFICATION
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Sheet 1

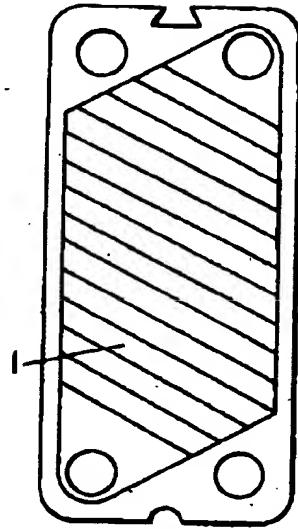


FIG. 1.

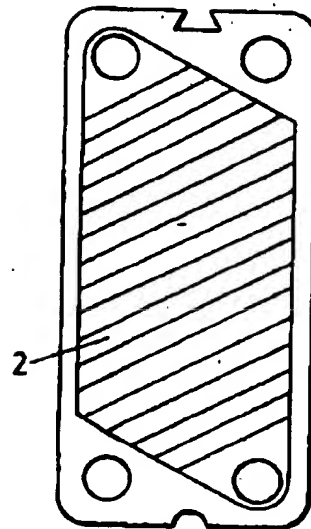


FIG. 2.

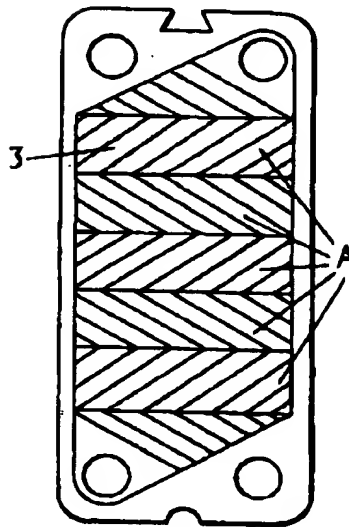


FIG. 3.

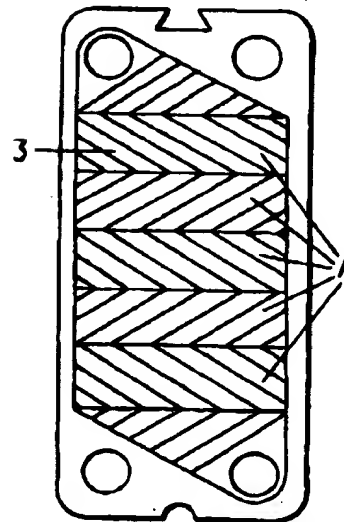


FIG. 4.

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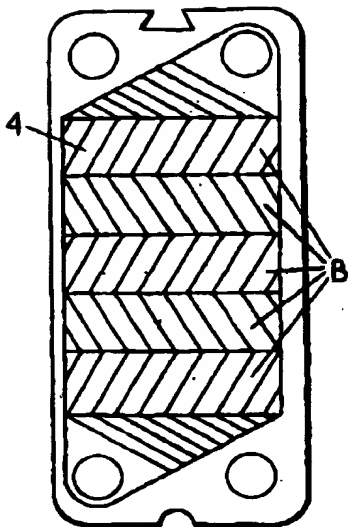


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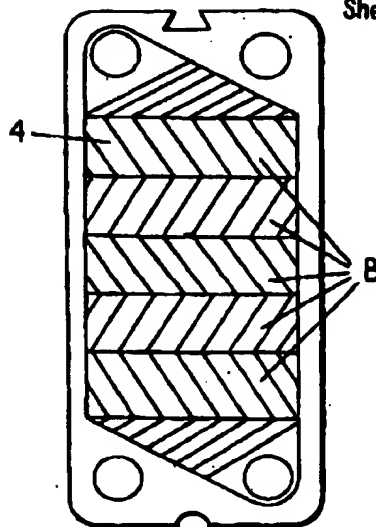


FIG. 6.

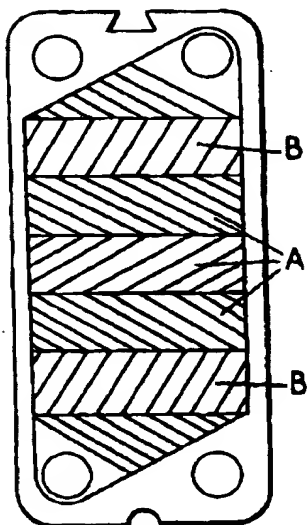


FIG. 7.

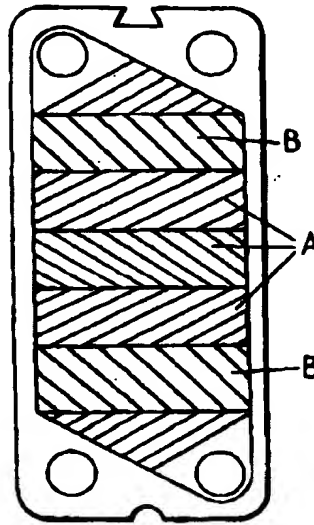


FIG. 8.

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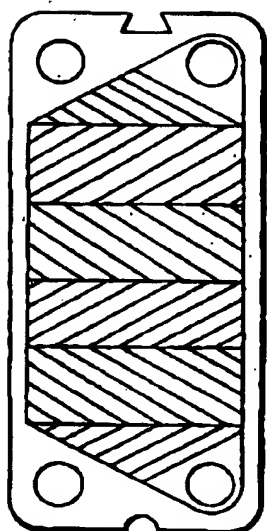


FIG. 9.

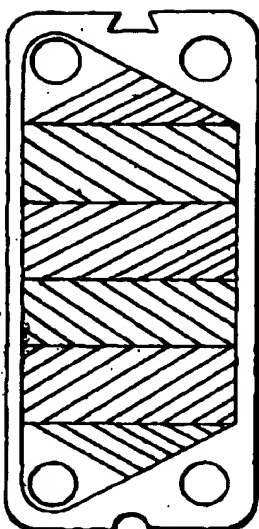


FIG. 10.

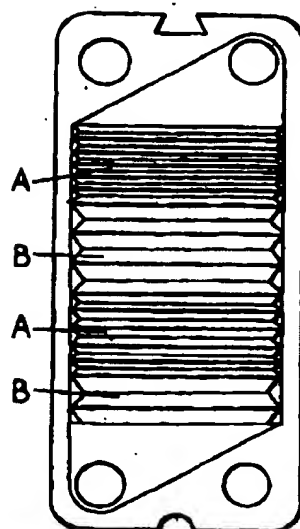


FIG. 11.



FIG. 12.

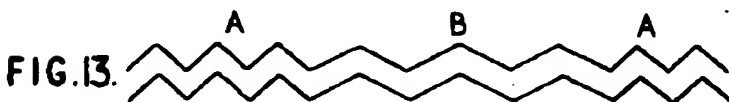


FIG. 13.



FIG. 14.

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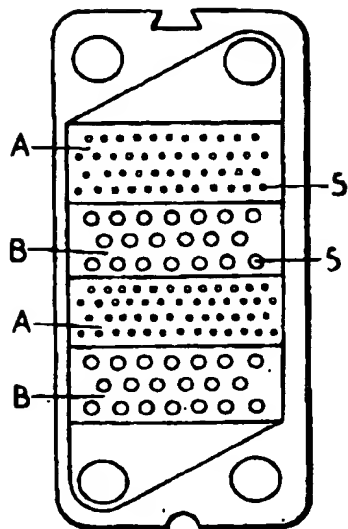


FIG. 15.

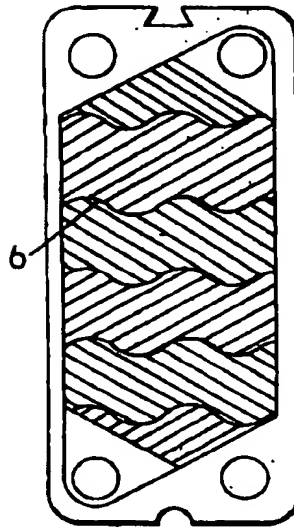


FIG. 16.

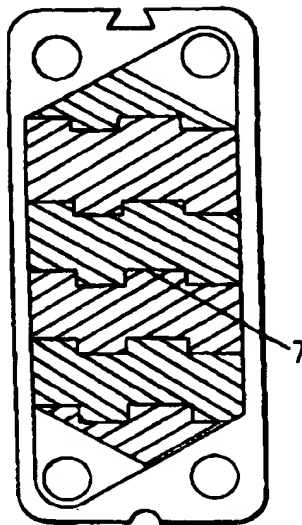


FIG. 17.

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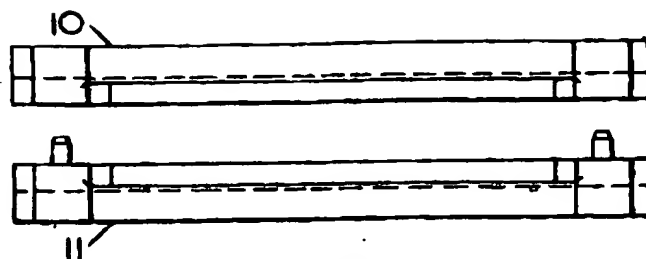


FIG. 18.

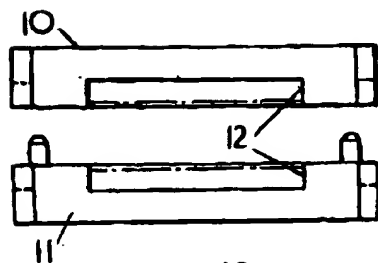


FIG. 19.

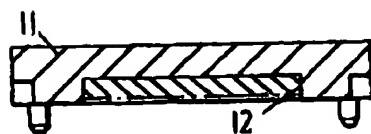


FIG. 21.

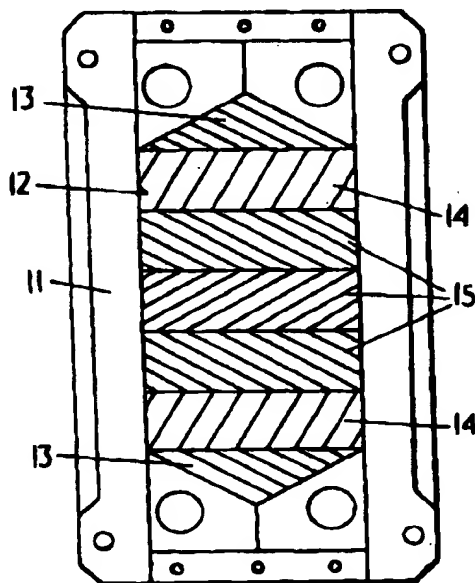


FIG. 20.

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COMPLETE SPECIFICATION

1 SHEET

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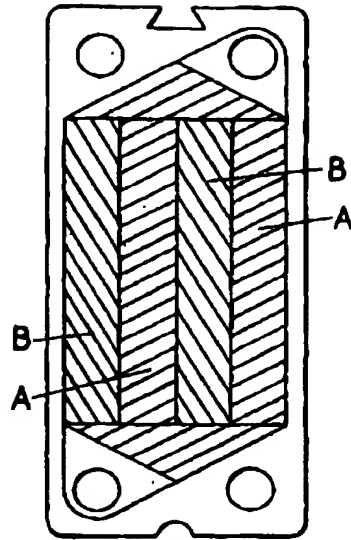


FIG. 22.

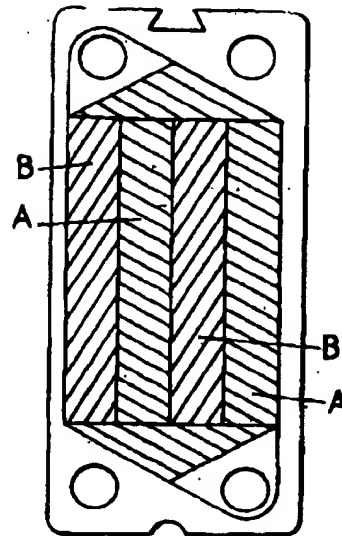


FIG. 23.

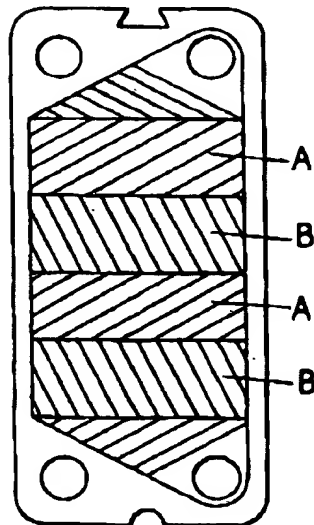


FIG. 24.

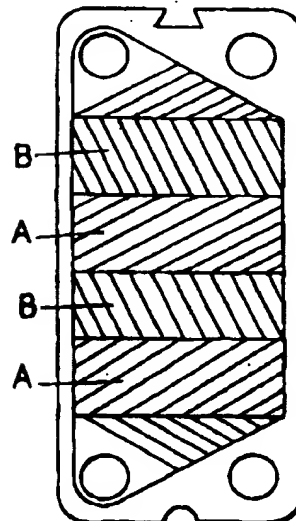


FIG. 25.

United States Patent [19]
Hultgren

[11] **4,407,357**
[45] **Oct. 4, 1983**

[54] **THIN SHEET METAL HEAT EXCHANGER**

[56]

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Primary Examiner—Sheldon J. Richter
Attorney, Agent, or Firm—Pennie & Edmonds

[57]

ABSTRACT

A thin metal heat exchanger having countercurrent flow of media on opposite sides of spaced walls is disclosed. The walls are configured with ridge-depression shapes extending at an angle to the direction of flow of media on opposite sides of the plate so as to create circulation but not turbulence of the flowing media in the depressions.

12 Claims, 6 Drawing Figures

[76] **Inventor:** Karl S. H. Hultgren, Rosengården,
S-560 41 Mullsjö, Sweden

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§ 371 Date: Dec. 23, 1980

§ 102(e) Date: Dec. 3, 1980

[87] **PCT Pub. No.:** WO80/02322

PCT Pub. Date: Oct. 30, 1980

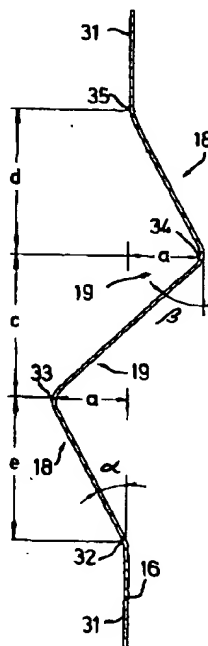
[30] **Foreign Application Priority Data**

Apr. 23, 1979 [SE] Sweden 79035358

[51] **Int. Cl.:** F28F 3/04

[52] **U.S. Cl.:** 165/165; 165/166

[58] **Field of Search** 165/165, 166



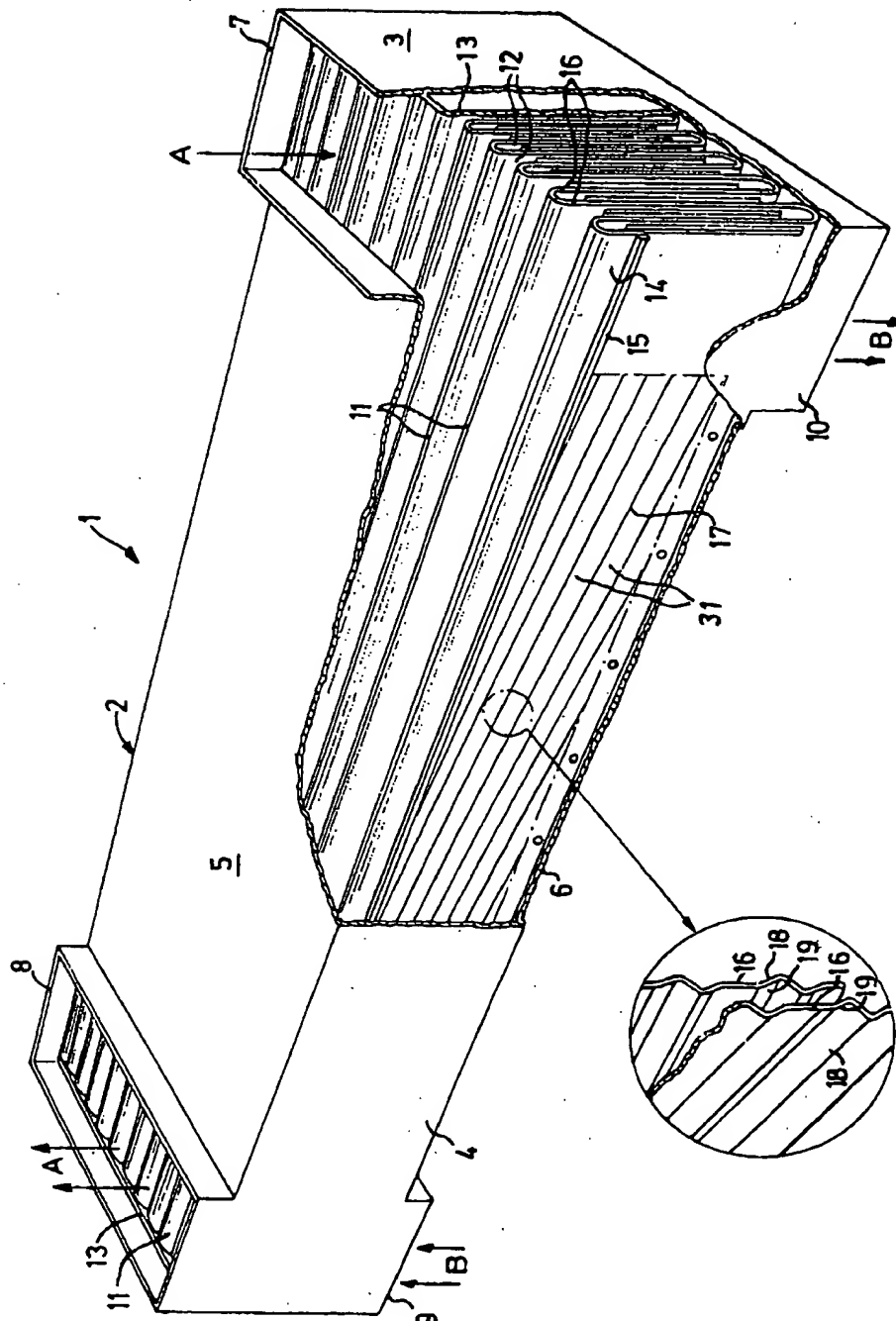


FIG. 1

FIG. 2

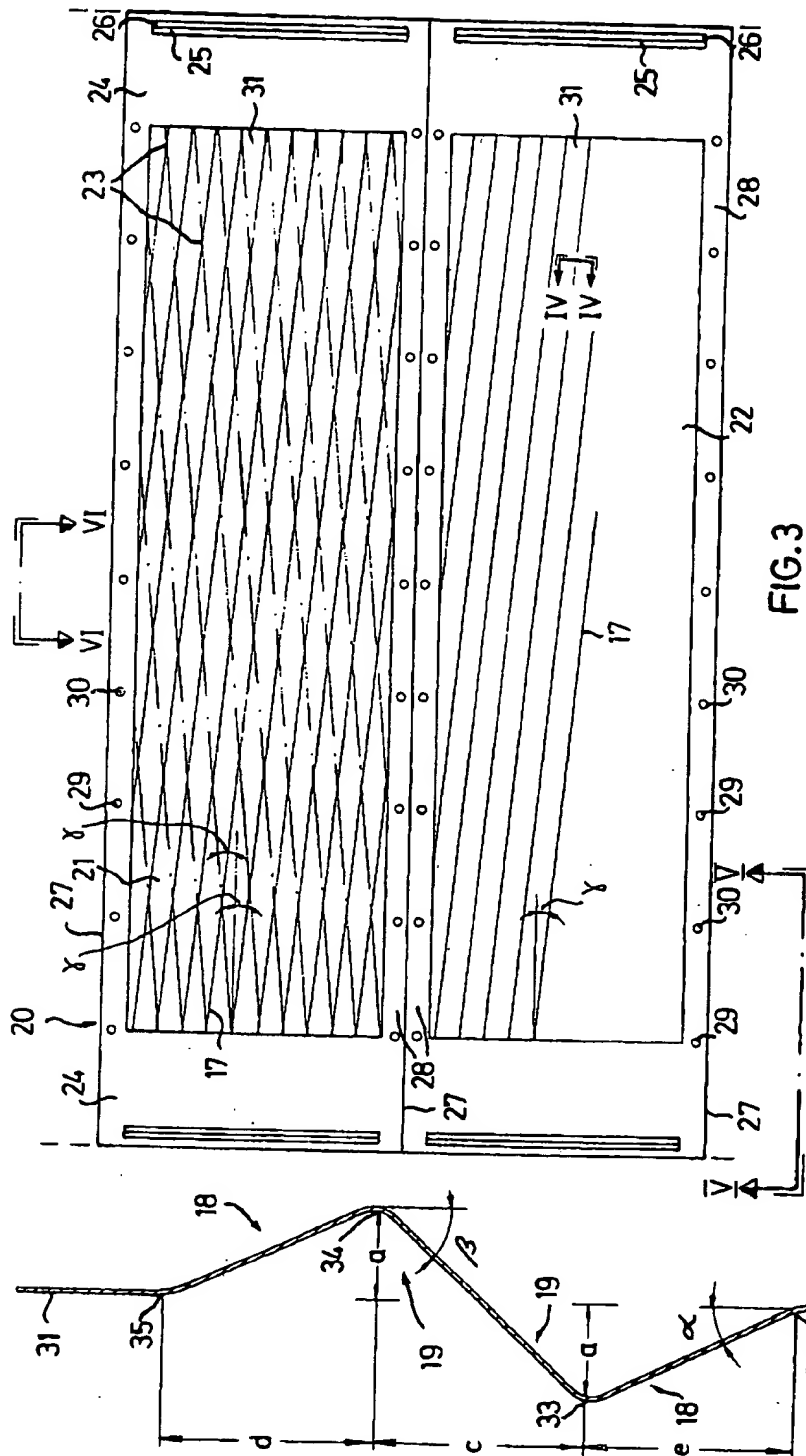


FIG. 3

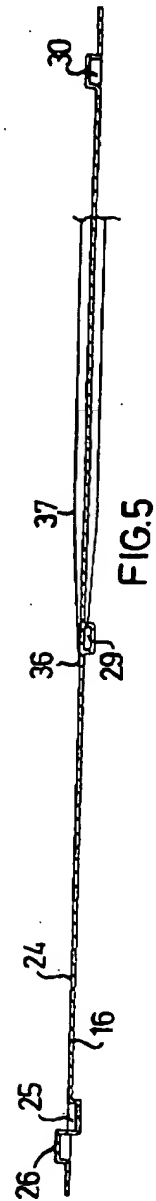
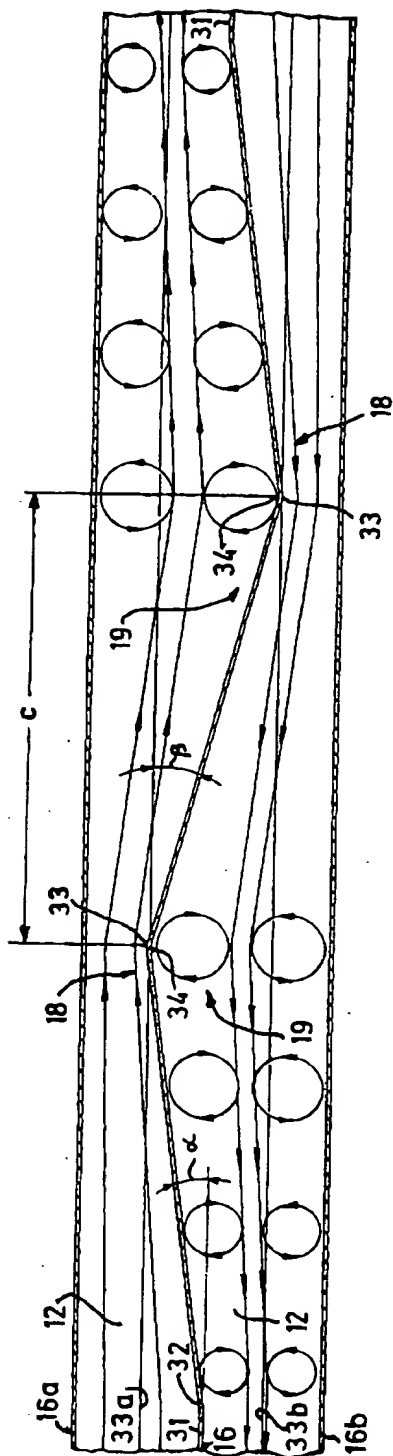


FIG. 5

FIG. 4

FIG. 6



THIN SHEET METAL HEAT EXCHANGER

The present invention relates to a heat exchanger for countercurrent heat exchange between two separated flowing media, consisting of a number of slots with common separating walls of thin sheet metal, preferably aluminium sheet metal, provided with profiles which cross each other on the adjacent separating walls and form spacer means at the points of crossing.

The invention is primarily intended to solve problems of heat exchange between two gaseous media, e.g. air/air, but it can be used to advantage for all types of heat exchange.

Heat exchangers with non-planar heat exchanger surfaces are known per se, e.g. provided with wave-shaped corrugations intended to break the boundary layer occurring during flow past the heat exchanger surfaces preventing or making more difficult the heat transfer. It has, however, been shown that this does not have any significant effect, especially as regards heat exchange between gaseous media.

It is also known to fold an endless metal sheet in 180° folds at even spacing to produce a package which, after being placed in a box and sealed at the ends, forms a heat exchanger with ducts, with every other channel opening towards one longside and every other channel opening against the opposite longside.

A heat exchanger of the type described above does not, however, provide any essential improvement in efficiency as compared with conventional heat exchangers, and as far as is known at the time of the present application there is no heat exchanger which is as highly suited for heat exchange between two gaseous media.

To improve the thermal exchange constant in heat exchange between two gaseous media which flow separated on either side of a common separating wall, the flow must be able to be affected so that boundary layers preventing heat transfer do not occur. Turbulence, however, must not be created since this results in high pressure drop at high heat exchange constants.

The purpose of the present invention is thus to achieve a heat exchanger with a significantly improved temperature efficiency in relation to previously known exchangers and which is especially well suited to heat exchange between gaseous media.

Another purpose of the invention is to achieve a heat exchanger which, with unchanged capacity, can be manufactured at much lower cost and which can be made smaller than conventional heat exchangers.

A more specific purpose of the invention is to achieve a heat exchanger which can be adapted to the desired flow rate so that a flow pattern is obtained which results in the temperature efficiency being significantly higher than in previously known heat exchangers.

This is achieved by means of the heat exchanger according to the invention, which is characterized in that its heat exchanger surfaces are formed by the two sides of the common separating walls for the two media;

that the profiles consist of a ridge and a depression and form an angle relative to the intended direction of flow through the heat exchanger, the profiles in each individual separating wall running parallel with each other with intermediate flat sheet metal portions, and that a ridge on one side of the separating wall corresponds to a depression on its other side;

that the height of the ridges above the flat sheet metal portion corresponds to half the depth of the depressions, measured from the top of one ridge to the bottom of the adjacent depression;

that the distance between the foot of the ridge and its top in the plane of the flat sheet metal portion is the same for the ridges on both sides of the separating wall, whereby the angle which the ridge forms relative to the flat sheet metal portion in the flow direction will be the same on both sides of the separating wall; and

that the portion of the separating wall which extends from the top of the ridge to the bottom of the depression forms an angle with the flat sheet metal portion which is adapted in relation to the Reynolds number at which the heat exchanger is to be used, so that circulation but not turbulence occurs in the depression at said Reynolds number.

This construction of the heat exchanger produces a circulation effect in the area of the profiled depressions of the particles in the flowing media, which pass the heat exchanger surfaces 5-10 times before they continue to the next profile. This circulation effect should not be confused with the eddies which occur in turbulence. The circulation effect according to the invention results in an appreciably increased temperature effect. A comparison between heat exchangers with and without profiles according to the invention resulted in differences by a factor of 4 in thermal exchange constants, and in certain cases the difference was even greater.

According to one embodiment of the invention, the angle in the direction of flow for the incline of the separating wall between the top of one ridge and the bottom of an adjacent depression was less than or equal to 20°. The degree of efficiency decreases for angles greater than 20°, which can be a result of the fact that turbulence effects then begin to occur. At angles somewhat greater than 20°, however, good temperature efficiencies are still obtained in comparison with when heat exchanger surfaces are used which are flat or profiled in a known manner.

According to another embodiment of the invention, the angle of incline for the separating wall between the top of one ridge and the bottom of a depression is chosen so that the distance between these points in the plane of the flat sheet metal portion is approximately half to twice the distance between the foot of one ridge and its top in said plane. The ratio between these two distances has been found to be crucial for obtaining the circulation effect according to the invention and it is dependent on the Reynolds number for the flowing media.

For Reynolds numbers in the lower laminar range, i.e. 500-1000, the distance in the plane of the flat sheet metal portion between the top of the ridge and the bottom of the depression should be approximately half the distance between the foot of the ridge and its top in said plane. Within the intermediate laminar range, i.e. Re 1000-1500, the distance should be approximately the same, and within the upper laminar range, i.e. Re 1500-2000, the distance between the top of the ridge and the bottom of the depression should be one and a half to twice the distance between the foot of the ridge and its top.

According to a further embodiment of the invention, the angle between the profiles and the flow direction of the media is preferably about 5°. This results in a favourable effect on the flow in that the particles during

circulation move somewhat along the depression, so that the particles will move in a helical path.

According to a further embodiment of the invention, the angle which the ridges form with the plane of the flat sheet metal portions is less than or equal to 10° in the direction of flow, so that the pressure drop will not be too great over the heat exchanger, but also to minimize the risk of turbulence at Reynolds numbers within the upper laminar range.

According to still another embodiment of the invention, the separating walls consist of a profiled endless metal sheet which has been folded in 180° folds with even spacing, or Z-shaped sheet metal members which are so profiled that the profiles on facing sides of the members cross each other in the heat exchanger.

According to a preferred embodiment of the invention, the angle in the direction of flow which the ridges form with the plane of the flat sheet metal portions is approximately 2.5° , and the angle of incline for the separating walls between the top of the ridges and the bottom of the adjacent depressions is approximately 5° , and the angle between the profiles and the flow direction of the media is 5° .

The invention is not, however, limited to said angle between the profiles and the flow direction. If this angle is instead selected to be about 90° , the profiles are made when the separating walls are manufactured, directly with the above-mentioned or other desired angles of incline which the profiles are to have in the flow direction of the media.

Further advantages and characteristics of the present invention will be evident from the detailed description below of the invention in connection with the accompanying drawings of which:

FIG. 1 is a partially cut away perspective view of the heat exchanger according to the invention;

FIG. 2 is a detail view of a cross section through two separating walls of the heat exchanger;

FIG. 3 is a schematic view of two separating walls before folding;

FIG. 4 is a cross section along the line IV—IV in FIG. 3 showing a profile according to the invention;

FIG. 5 is a cross section along the line V—V in FIG. 3 showing a portion of a separating wall next to an end piece; and,

FIG. 6 is a cross section along the line VI—VI in FIG. 3 showing, perpendicularly to the flow direction, a profile with flow lines to illustrate the circulation effect, which gives the heat exchanger according to the invention its exceptionally high efficiency.

The heat exchanger shown in FIG. 1 is generally designated 1 and consists of a box 2 with two ends 3, two side walls 4, a cover 5 and a bottom 6. These are joined in a conventional manner by welding, and/or bolts. In the cover 5 and bottom 6, connecting pieces are arranged for the flowing media which are to be heat-exchanged with each other. In the cover 5 an inlet connection 7 and an outlet connection 8 are arranged for a first medium, the flow direction of which is shown with arrows "A". In the bottom 6, an inlet connection 9 and an outlet connection 10 are arranged for a second medium, the flow direction of which is shown with arrows "B". A folded sheet 11 is arranged in the heat exchanger box 2, said sheet forming slots 12 for the flowing media. As can be seen from the figure, every other slot is open towards the cover 5 and every other slot towards the bottom 6. Seals 13 are arranged against the ends 3, preferably by casting in a plastic composi-

tion which bakes in the edge of the sheet, thus hermetically sealing the slots 12. Sealing strips 15 of rubber or the like are arranged between the side walls 4 and the two outermost portions 14 of the sheet. No seals are required against the cover and the bottom since the same medium flows in all the slots which open towards the cover or towards the bottom.

The folded sheet 11 forms separating walls 16 which are common to the adjacent slots 12. The two surfaces of the separating walls are thus the heat exchanger surfaces of the heat exchanger. The separating walls 16 are provided with profiles 17 which are indicated with solid lines in FIG. 1.

FIG. 2 shows in an enlarged scale a cross section through two of the separating walls 16. The profiles 17 consist of a ridge 18 and a depression 19. Within each separating wall the profiles 17 run parallel with each other, while the profiles of the adjacent walls cross each other.

FIG. 3 shows a metal sheet 20 which has still not been folded, with two profiled heat exchanger surfaces 21 and 22. When manufacturing the heat exchanger a metal sheet is profiled, the length of which is limited by the tool used. The profiled sheets are then joined together to the required length by folding, for example. As can be seen from FIG. 3, the profiles 17 run parallel to each other at an angle γ in relation to the transverse direction of the sheet, i.e. in relation to what is to be the longside of the separating walls. After folding, the profiles will cross each other and make contact at the crossing points 23.

The profiles do not run all the way out to the edges of the sheet, but a flat sheet portion 24 is left at each edge. These flat sheet portions 24 form inlet boxes for the flowing media, resulting in a more even inflow and distribution over the cross section of the slots 12. At the edges of the first sheet portions 24, long indentations 25 and raised portions 26 are arranged, which have the same height or depth as the ridges of the profiles and after folding will be in contact with each other on the adjacent walls.

The profiles 17 do not either extend all the way to the line 27 along which the metal sheet is to be folded, but flat sheet portions 28 provided with cylindrical indentations 29 and raised portions 30 are left there. After folding, these indentations and raised portions as well will be in contact with each other on the adjacent walls.

The indentations 25, 29 and raised portions 26, 30 will, together with the profiles 17 at the cross points 23, form a large number of spacer means so that the separating walls 16 will remain essentially unaffected even under large pressure loads. The main objective hereby is to avoid deformation of the profiles at the cross points.

Between the profiles 17 there are flat sheet portions 31. Their width depends of the maximum allowable pressure drop over the heat exchanger. The more closely the profiles are spaced, the higher the pressure drop over the heat exchanger. It is normally suitable to arrange these flat sheet portions with approximately the same width as the profiles.

FIG. 4 shows a cross section through a profile 17 along the line IV—IV in FIG. 3. In the profile shown, a first medium is intended to flow from the left to the right in the figure above the separating wall, while a second medium is intended to flow in the opposite direction beneath the separating wall.

The profile 17 thus consists of a ridge 18 and a depression 19. From the foot 32 of the ridge to its top 33, the

separating wall 16 is inclined as an angle α in relation to the plane of the flat sheet portion. From the top 33 of the ridge to the bottom of the depression, the separating wall 16 is inclined at an angle β in relation to the plane of the flat sheet portion and from the bottom of the depression 34 to the foot 35 of the ridge formed on the wall's 16 opposite side of the depression at the angle α in relation to the plane of the flat sheet portion.

The height of the ridge 18 is designated "a" and when the profiles are symmetrical, the depth of the depression will be equal to twice the height. Furthermore, the distance "e" from the foot 32 of the ridge to its top 33 is equal to the distance "d" from the bottom 34 of the depression to the foot 35 of the ridge, on the opposite side of the separating wall 16. The distance "c" from the top 33 of the ridge to the bottom 34 of the depression is in a certain proportion to the distance "e" depending on the Reynolds number for which the heat exchanger is intended. This will be treated in more detail below in connection with FIG. 6. The ratio between the distances "c" and "e" are varied by changing the angle α in the profiling process.

The folds at the ridge and depression of the profile must of course be softly rounded and not sharp, both for reasons of strength and flow considerations.

FIG. 5 shows a cross section along the line V—V in FIG. 3 through a portion of a separating wall 16. The indentations 25 and raised portions 26 forming the spacer means are arranged close to the outer edge of the flat sheet portion 24. The cylindrical indentations 29 and raised portions 30 are arranged alternating. Preferably the profiles do not begin abruptly but, as shown in the figure, gradually within the range 36–37 after which they reach full height. A similar range is disposed on the other side of the profiled sheet portions.

FIG. 6 shows a cross section along the line VI—VI in FIG. 3 through three separating walls 16, 16a and 16b, viewed perpendicularly to the direction of flow. Schematic flow lines illustrate the circulation effect achieved by the profiles and which provide the heat exchanger according to the invention with its high efficiency. The slot width between the flat sheet portions of the separating walls corresponds to twice the ridge height. The ridges of the separating walls 16a and 16b are indicated by solid lines 33a and 33b.

The circulation effect occurs after a transition point which lies immediately after the bottom 34 of the depression. Mathematically it can be shown that the transition point lies at a distance $9/7 \times c$ from the top 33 of the ridge. To achieve maximum circulation effect, the distance "c" must be adapted to the Reynolds number in question. Within the lower laminar range, i.e. for Re 500–1000, "c" should be about equal to half the distance "e" between the foot 32 of the ridge and its top 33. Within the intermediate laminar range "c" should be

about equal to "e", and within the upper laminar range "c" should be about 1.5–2 times "e".

As the flow lines in the figure indicate, the circulation effect results in each media particle coming into contact with the heat exchanger surfaces a number of times due to circulation, which improves the thermal exchange constant for the heat exchanger many times over. This circulation should not be confused with the turbulent eddies which occur at Reynolds numbers above about 2000. The flow is laminar even within the narrowest section, i.e. at the top 33 of the ridge, while the speed at the transition point is substantially lower. Actually, here both a positive and a negative flow speed are obtained, which results in circulation. This circulation is directed towards both of the adjacent surfaces from a main flow portion midway between the heat exchanger surfaces, cf. the flow lines in the figure.

Thus a maximum circulation effect can be obtained at a desired Reynolds number by varying the distance "c" according to the above.

Irregularities in the flow occur past the points where the profiles cross each other. This does not, however, affect the efficiency of the heat exchanger to any appreciable degree.

Due to the fact that the profiles 17 are obliquely arranged in relation to the flow direction, cf. angle γ in FIG. 3, a certain movement along the depression occurs, so that the particles can be said to move helically.

The angle of incline α for the separating wall 16 between the foot 32 of the ridge and its top 33 should not exceed about 10° in the direction of flow. It is true that the effect is still present above this value as well, but the results are poorer due to the powerful directional changes which the flowing medium is subjected to. An angle α of about 5° is preferred.

The angle of incline β for the separating wall 16 between the top 33 of the ridge and the bottom 34 of the depression should not exceed 20° . Its size depends on the desired length of the distance "c" between these two points.

To further illustrate the invention, the following are the results of a test conducted with a prototype heat exchanger in which the distance between the centres of the profiles was 25 mm, the gap width was 3.45 mm, the hydraulic diameter was 6.06×10^{-3} mm, the number of slots for each medium was 41 and the total heat surface was 20.5 m^2 .

The theoretical k-value, k_t , was calculated from Nusselt's equation, while the actual k-value, k_a , was calculated with the aid of the formula $Q = k_a \times 20.5 \times \Delta t$, where Q is the energy flow and Δt is the mean temperature difference. The k-values apply at a section before a profile for the exhaust air and consequently after a profile for the fresh air. During the test the Re number was about 800–1250, i.e. clearly within the laminar range.

TABLE

Trial	Exhaust air			Fresh air			efficiency	Temperature		
	t_{in}	t_{out}	t	t_{in}	t_{out}	t		k_t	k_a	k_a/k_t
1	23.5	13.5	10.0	11.5	23.1	11.6	0.900	6.8	35.8	5.26
2	24	12	12	11.6	23.5	11.9	0.964	7.8	94.4	12.1
3	24.2	14	10.2	13.5	23.5	20	0.94	7.4	90.3	12.2
4	24.5	14.8	9.7	14	24	10	0.94	7.3	53.7	7.36
5	25.3	15.5	9.8	15	23.9	8.9	0.91	7.4	39.9	5.39
6	25	15.6	9.4	15.1	24.4	9.3	0.94	7.5	60.5	8.07
7	26	16.3	9.7	15.9	25.6	9.7	0.96	6.85	77.3	11.28

7
TABLE-continued

Trial	Exhaust air			Fresh air			Temperature efficiency	k_i	k_p	k_p/k_i
	t_{in}	t_{out}	t	t_{in}	t_{out}	t				
								mean value		8.81

As can be seen from the table, the mean value for the ratio k_p/k_i was greater than 8. This is a very surprising result which demonstrates that the heat exchanger according to the invention is quite effective and usable.

In the prototype heat exchanger, the width of the profiles measured perpendicular to their longitudinal direction is 10.5 mm. For flow within the intermediate laminar range the distances "c", "d" and "e" were all equal to 3.5 mm. Due to the fact that the profiles form an angle γ of 5° with the flow direction, the profile will have the appearance shown in FIG. 6 where the angle α is approximately equal to 2.5° and the angle β is approximately equal to 5°.

By virtue of the high degree of efficiency, as demonstrated by the above test results, the heat exchanger can be made say 4 times smaller than corresponding conventional heat exchangers and still produce corresponding temperature effects. By virtue of the fact that the heat exchanger according to the invention can also be manufactured with relatively simple tools and be mass produced on an assembly line, the production cost makes the heat exchanger particularly well suited for use in dwellings, for example. It can also be used for heat exchange between liquid media such as water, and between gas and liquid, making the range of use virtually unlimited.

I claim:

1. Heat exchanger for countercurrent heat exchange between two separated flowing media, consisting of a number of slots with common separating walls of thin sheet metal, preferably aluminium sheet metal, provided with profiles which cross each other on adjacent separating walls and form spacer means at the crossing points, characterized in that its heat exchanger surfaces are formed by the two sides of the separating walls (16) common to the two media, that the profiles consist of a ridge (18) and a depression (19) and are arranged at an angle (γ) in relation to the intended direction of flow through the heat exchanger, the profiles (17) on each individual separating wall (16) running parallel with each other with intermediate flat sheet metal portions (31), and that a ridge on one side of the separating wall corresponds to a depression on its other side, the height (a) of the ridges (18) above the flat sheet metal portions (31) corresponds to half the depth of the depressions (19), measured from the top of one ridge to the bottom of the adjacent depression, that the distance (e) between the foot (32) of the ridge and its top (33) in the plane of the flat sheet metal portion (31) is the same for the ridges on both sides of the separating wall, whereby the angle (α), which the ridge forms with the flat sheet metal portion in the flow direction, will be the same on both sides of the separating wall, and that the portion of the separating wall which extends from the top (33) of the ridge to the bottom (34) of the depression forms an angle (β) with the flat sheet metal portion (31) in the flow direction which is adapted in relation to the Reynolds number at which the heat exchanger is to be used, so that circulation but not turbulence occurs in the depression at said Reynolds number.

2. Heat exchanger according to claim 1, characterized in that the separating wall (16) between the top (33) of a ridge (18) and the bottom (34) of the adjacent depression (19) is inclined in relation to the flat sheet metal portion (31) at an angle (β) which is smaller than or equal to 20° in the direction of flow.

3. Heat exchanger according to claim 1, characterized in that the angle of incline (β) of the separating wall (16) between the top (33) of the ridge and the bottom (34) of the depression is selected so that the distance (c) between these points in the plane of the flat sheet metal portion is approximately half to twice the distance (e) between the foot of a ridge and its top in said plane.

4. Heat exchanger according to claim 3, characterized in that for Reynolds numbers of 500-1000 the distance (c) between the top (33) of the ridge and the bottom (34) of the depression in the plane of the flat sheet metal portion is approximately half the distance (e) between the foot (32) of the ridge and its top (33) in said plane.

5. Heat exchanger according to claim 3, characterized in that for Reynolds numbers of 1000-1500 the distance (c) between the top (33) of the ridge and the bottom (34) of the depression in the plane of the flat sheet metal portion is approximately equal to the distance (e) between the foot of the ridge and its top in said plane.

6. Heat exchanger according to claim 3, characterized in that for Reynolds numbers of 1500-2000 the distance (c) between the top (33) of the ridge and the bottom (34) of the depression is approximately 1.5-2 times the distance (e) between the foot (32) of the ridge and its top (33) in said plane.

7. Heat exchanger according to claim 1, characterized in that the separation wall (16) from the foot (32) of the ridge to any one of its top (33) forms an angle (α) with the flat sheet metal portion (31) which is smaller than or equal to about 10°.

8. Heat exchanger according to claims 1-6 or 7, characterized in that the separating walls (16) consist of a profiled endless metal sheet which has been folded in 180° folds with even spacing.

9. Heat exchanger according to any one of claims 1-6 or 7, characterized in that the angle (γ) between the profiles (17) and the direction of flow is approximately 5°.

10. A counter-current heat exchanger, with separated flowing media, comprising a body with heat carrying media inlet and outlet connections and a heat exchanging surface in the shape of a folded thin sheet metal, said sheet being folded in 180° folds with the adjacent sheets defining separating walls forming media flow channels therebetween and having inclined parallel corrugations characterized in that the corrugations cross each other on adjacent separating walls at an angle to the direction of flow of media through said channels and are grouped in ridge-depression pairs separated by intermediate flat surfaces, the distance (c) between the top (33) of the ridge (18) and the bottom (34) of the depression (19), as

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measured in the plane of the flat surface (31), being equal in each pair and half to twice the distance (e) between the foot (32) of the ridge (18) and its top (33), and that the walls of corrugations between tops and intermediate flat surfaces are arranged at angle angle (α) of not more than 10° to said flat surfaces in the direction of flow of media through said channels.

11. A heat exchanger according to claim 10, characterized in that walls of the corrugations between the

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tops and bottoms (33, 34) in each pair is arranged at an angle (β) not more than 20° relative to the plane of the flat surfaces in the direction of said flow of media.

12. A heat exchanger according to either of claims 10 and 11, characterized in that the angle (γ) between the corrugations and the direction of said flow is approximately 5°.

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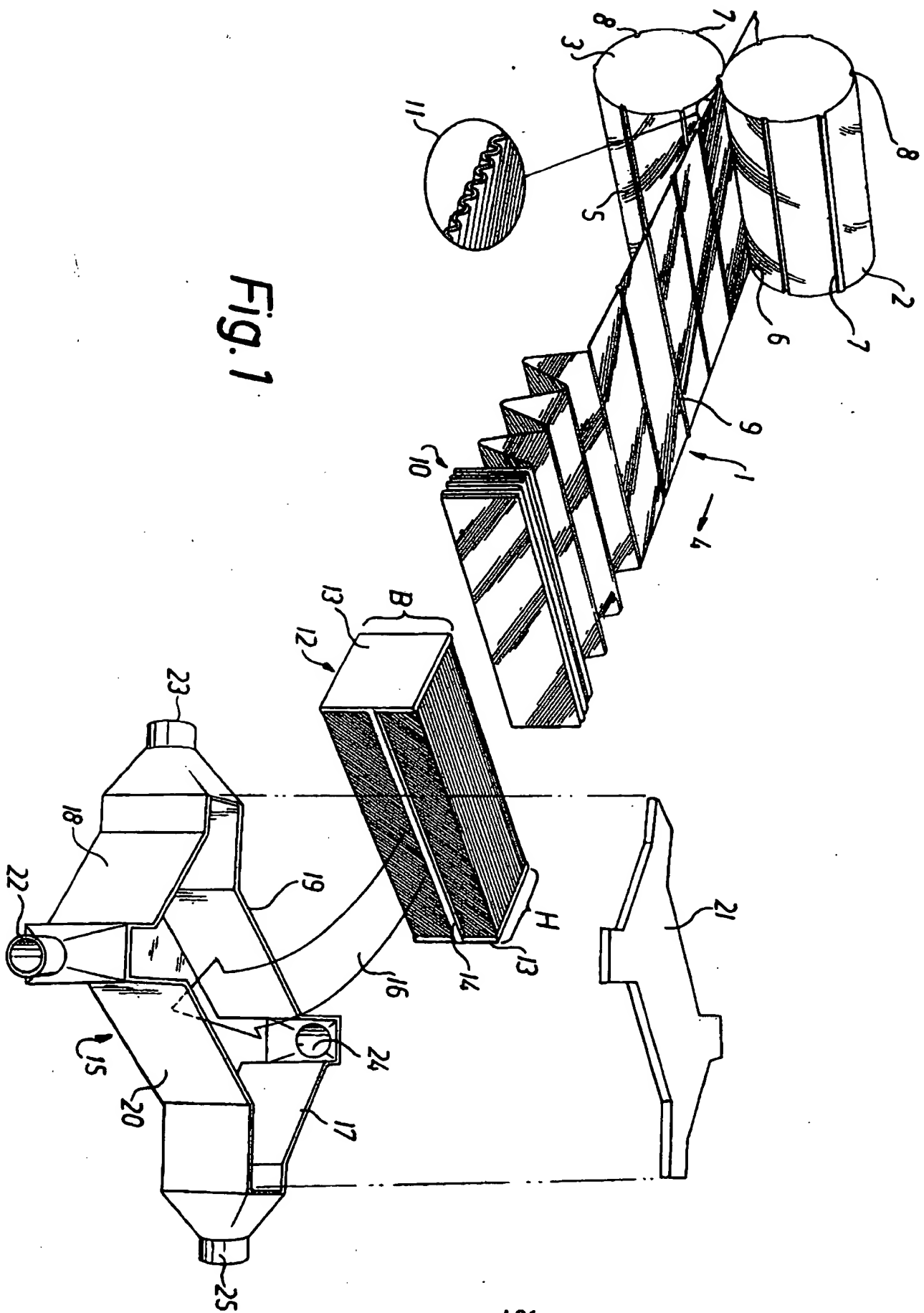
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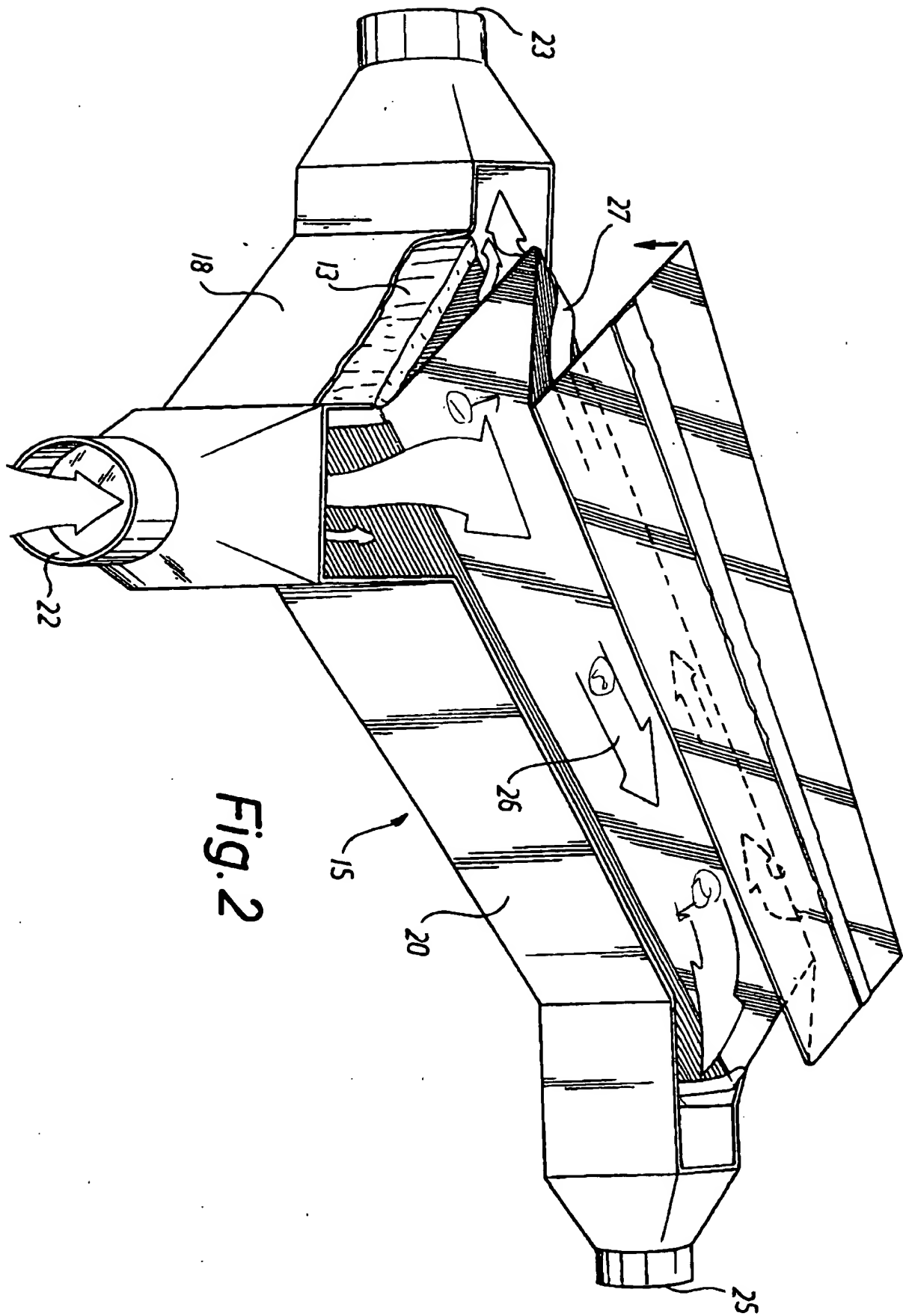
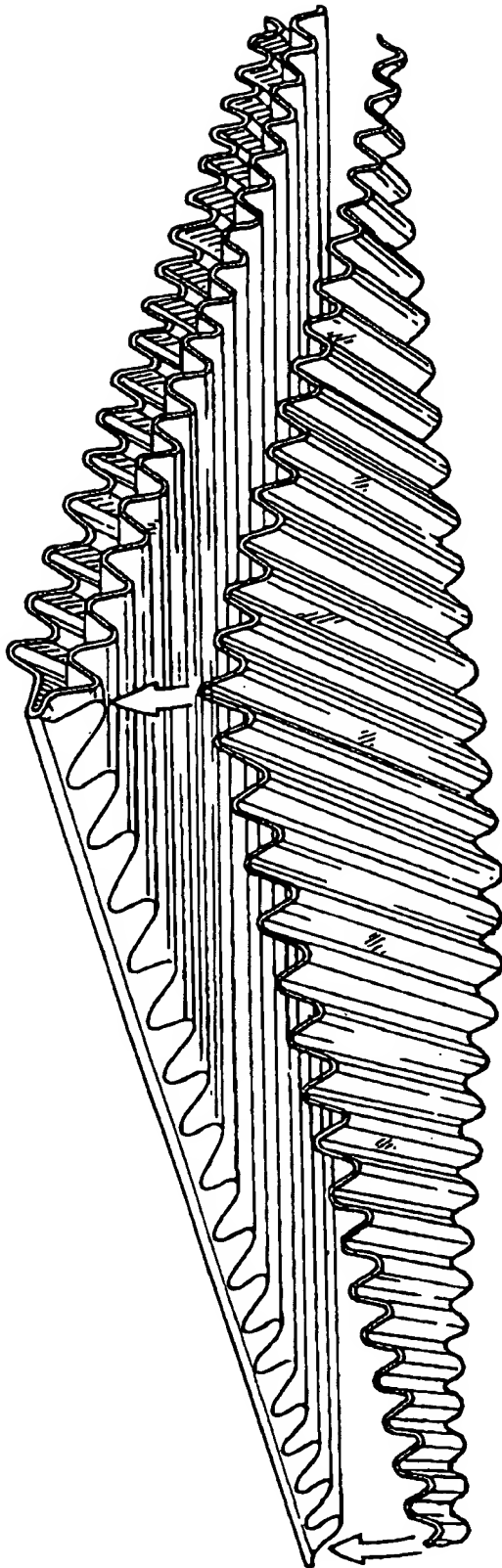


Fig. 3



A33

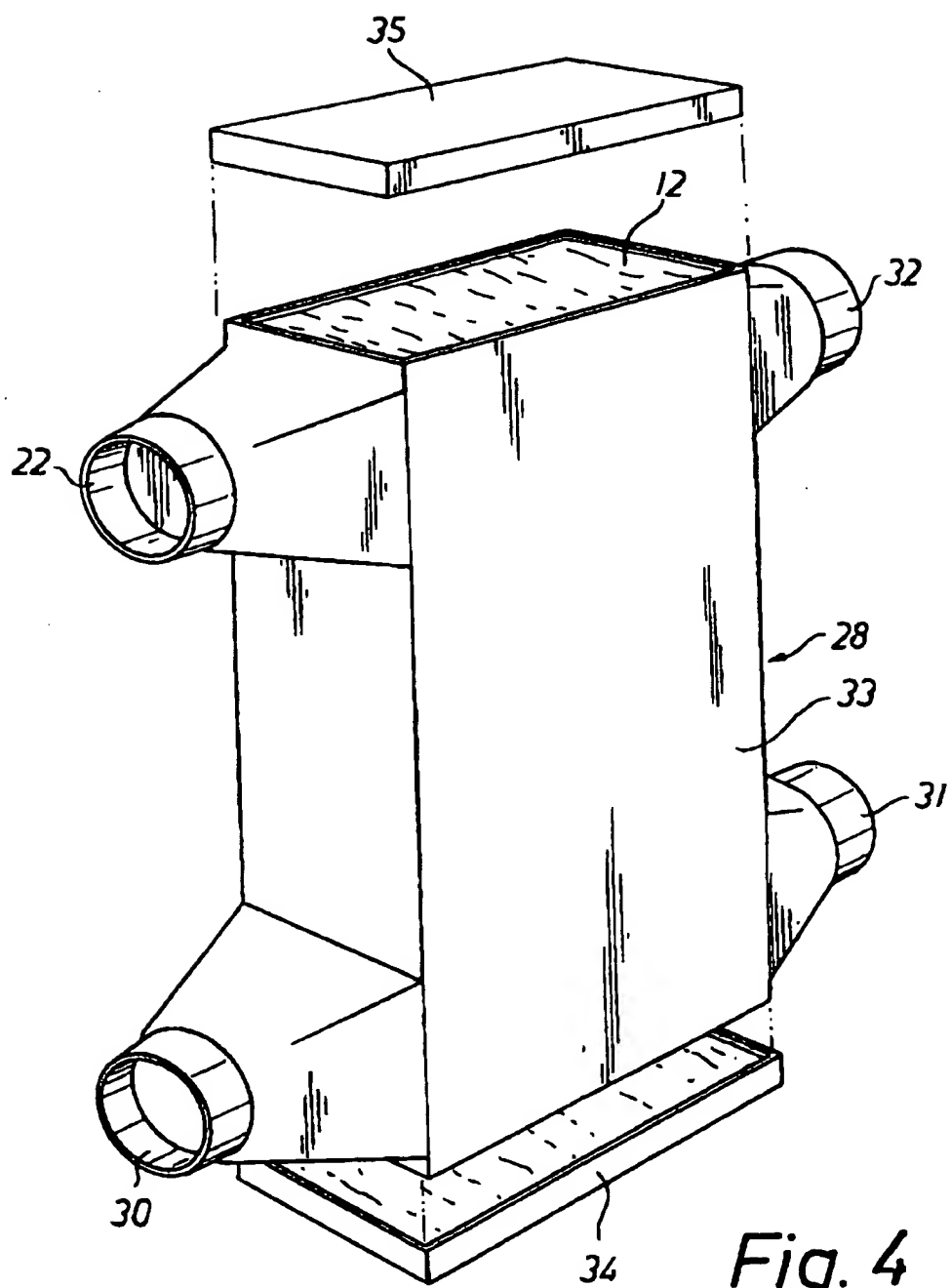


Fig. 4

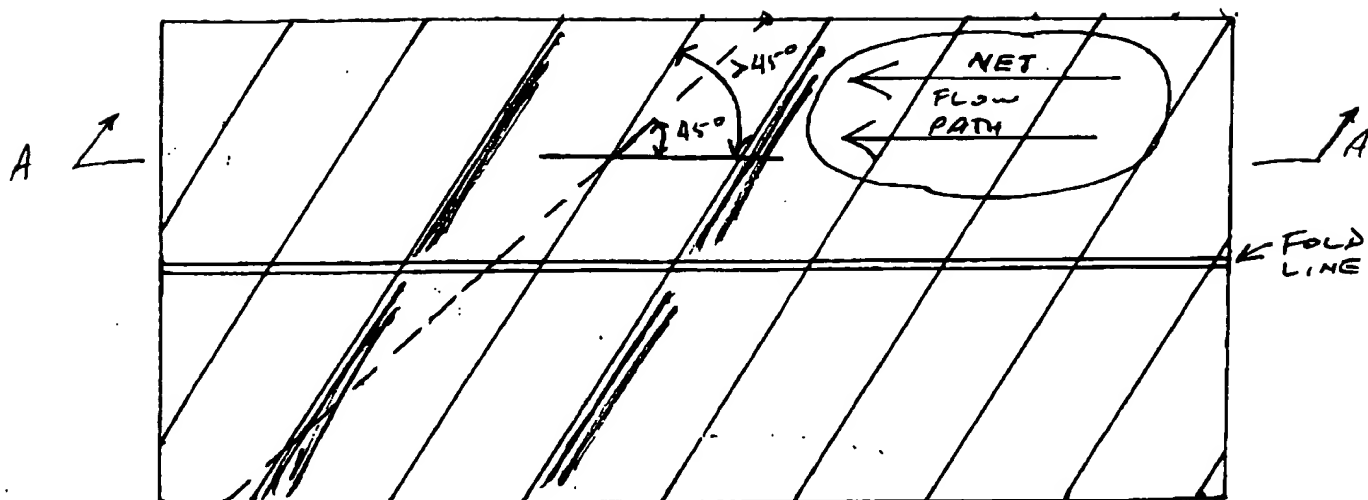


FIG. 5



FIG. 6



A-A FIG. 7



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*277 F.3d 1338, *; 2002 U.S. App. LEXIS 855, **;
61 U.S.P.Q.2D (BNA) 1430*

IN RE SANG SU LEE

00-1158

UNITED STATES COURT OF APPEALS FOR THE FEDERAL CIRCUIT

277 F.3d 1338; 2002 U.S. App. LEXIS 855; 61 U.S.P.Q.2D (BNA) 1430

January 18, 2002, Decided

PRIOR HISTORY: **[**1]** Appealed from: Patent & Trademark Office Board of Patent Appeals and Interferences. (Serial No. 07/631,240).

DISPOSITION: Vacated and remanded.

CASE SUMMARY


PROCEDURAL POSTURE: Appellant inventor appealed the decision of the United States Board of Patent Appeals and Interferences (Board) rejecting all of the claims of the inventor's patent application that was directed to a method of automatically displaying the functions of a video display device and demonstrating how to select and adjust the functions in order to facilitate response by the user.


OVERVIEW: The patent examiner had rejected the inventor's claims on the ground of obviousness. In its decision, the Board rejected the need for any specific hint or suggestion in a particular reference to support the combination of two cited references. It held that it was not necessary to present a source of a teaching, suggestion, or motivation to combine these references or their teachings. The court of appeals found that the "common knowledge and common sense" on which the Board relied in rejecting the inventor's application were not the specialized knowledge and expertise contemplated by the Administrative Procedure Act (APA). Conclusory statements such as those provided did not fulfill the agency's obligation. The Board's analysis of the invention did not comport with either the legal requirements for determination of obviousness or with the requirements of the APA that the agency tribunal set forth the findings and explanations needed for reasoned decisionmaking. Remand for these purposes was required. The court declined to consider alternative grounds that might have supported the Board's decision, because they were not relied upon in the Board's decision.


OUTCOME: The court of appeals vacated the Board's decision, and remanded for further proceedings.

CORE TERMS: examiner, combine, motivation, obviousness, teaching, demonstration, skill, tribunal, patentability, Administrative Procedure Act, common sense, patent, invention, display, expertise, common knowledge, picture, game, judicial review, video, automatically, automatic, select, user, agency action, conclusory, effective, set forth, displaying, tutorial


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HN1  Tribunals of the United States Patent and Trademark Office are governed by the Administrative Procedure Act, and their rulings receive the same judicial deference as do tribunals of other administrative agencies. [More Like This Headnote](#)


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HN2  See 5 U.S.C.S. § 706(2).


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HN3  For judicial review to be meaningfully achieved within the strictures of 5 U.S.C.S. § 706(2), the agency tribunal must present a full and reasoned explanation of its decision. The agency tribunal must set forth its findings and the grounds thereof, as supported by the agency record, and explain its application of the law to the found facts. The Administrative Procedure Act (APA), which governs the proceedings of administrative agencies and related judicial review, establishes a scheme of "reasoned decisionmaking." Not only must an agency's decreed result be within the scope of its lawful authority, but the process by which it reaches that result must be logical and rational. This standard requires that the agency not only have reached a sound decision, but have articulated the reasons for that decision. The reviewing court is thus enabled to perform meaningful review within the strictures of the APA, for the court will have a basis on which to determine whether the decision was based on the relevant factors and whether there has been a clear error of judgment. [More Like This Headnote](#)


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HN4  Judicial review of a United States Board of Patent Appeals and Interferences decision denying an application for a patent is founded on the obligation of the agency to make the necessary findings and to provide an administrative record showing the evidence on which the findings are based, accompanied by the agency's reasoning in reaching its conclusions. [More Like This Headnote](#)


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HN5  As applied to the determination of patentability vel non when the issue is obviousness, it is fundamental that rejections under 35 U.S.C.S. § 103 must be based on evidence comprehended by the language of that section. [More Like This Headnote](#)


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HN6  The patent examination process centers on prior art and the analysis thereof. When patentability turns on the question of obviousness, the search for and analysis of the prior art includes evidence relevant to the finding of whether there is a teaching, motivation, or suggestion to select and combine the references relied on as evidence of obviousness. The central question is whether there is reason to combine the references, a question of fact drawing on the Graham factors. The factual inquiry whether to combine references must be thorough and searching. It must be based on objective evidence of record. This precedent cannot be dispensed with. [More Like This Headnote](#)

[Patent Law](#) > [Nonobviousness](#) > [Tests & Proof of Obviousness](#) 

HN7  In the context of obviousness in patent applications, even when the level of skill in the art is high, the United States Board of Patent Appeals and Interferences must identify specifically the principle, known to one of ordinary skill, that suggests the claimed combination. In other words, the board must explain the reasons one of ordinary skill in the art would have been motivated to select the references and to


combine them to render the claimed invention obvious. [More Like This Headnote](#)

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HN8 In considering obviousness in patent applications, the factual question of motivation is material to patentability, and cannot be resolved on subjective belief and unknown authority. It is improper, in determining whether a person of ordinary skill would have been led to a combination of references, simply to use that which the inventor taught against its teacher. Thus the United States Board of Patent Appeals and Interferences must not only assure that the requisite findings are made, based on evidence of record, but must also explain the reasoning by which the findings are deemed to support the agency's conclusion. [More Like This Headnote](#)

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HN9 Deferential judicial review under the Administrative Procedure Act does not relieve the agency of its obligation to develop an evidentiary basis for its findings. To the contrary, the Administrative Procedure Act reinforces this obligation. The agency must examine the relevant data and articulate a satisfactory explanation for its action, including a rational connection between the facts found and the choice made. [More Like This Headnote](#)

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HN10 Omission of a relevant factor required by precedent is both legal error and arbitrary agency action. [More Like This Headnote](#)

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HN11 Reasoned findings are critical to the performance of agency functions and judicial reliance on agency competence. [More Like This Headnote](#)

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HN12 Deficiencies of the cited references cannot be remedied by the United States Board of Patent Appeals and Interferences' general conclusions about what is "basic knowledge" or "common sense." The board's findings must extend to all material facts and must be documented on the record, lest the haze of so-called expertise acquire insulation from accountability. Common knowledge and common sense, even if assumed to derive from the agency's expertise, do not substitute for authority when the law requires authority. Because reasoned decisionmaking demands it, and because the systemic consequences of any other approach are unacceptable, the tribunal must be required to apply in fact the clearly understood legal standards that it enunciates in principle. [More Like This Headnote](#)


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HN13 In resolving the issue of obviousness in patent applications, common knowledge and common sense may be applied to analysis of the evidence. [More Like This Headnote](#)

[Patent Law](#) > [Patentable Subject Matter](#)


HN14 Determination of patentability must be based on evidence. [More Like This Headnote](#)


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[Patent Law](#) > [Jurisdiction & Review](#) > [Standards of Review](#) 


HN15 The patent examiner and the United States Board of Patent Appeals and Interferences are deemed to have experience in the field of the invention; however, this experience, insofar as applied to the determination of patentability, must be applied from the viewpoint of the person having ordinary skill in the art to

which said subject matter pertains. In finding the relevant facts, in assessing the significance of the prior art, and in making the ultimate determination of the issue of obviousness, the examiner and the board are presumed to act from this viewpoint. Thus when they rely on what they assert to be general knowledge to negate patentability, that knowledge must be articulated and placed on the record. The failure to do so is not consistent with either effective administrative procedure or effective judicial review. The board cannot rely on conclusory statements when dealing with particular combinations of prior art and specific claims, but must set forth the rationale on which it relies. [More Like This Headnote](#)


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HN16  Courts may not accept appellate counsel's post hoc rationalization for agency action. Consideration by the appellate tribunal of new agency justifications deprives the aggrieved party of a fair opportunity to support its position; thus review of an administrative decision must be made on the grounds relied on by the agency. If those grounds are inadequate or improper, the court is powerless to affirm the administrative action by substituting what it considers to be a more adequate or proper basis. If a reviewing court agrees that the agency misinterpreted the law, it will set aside the agency's action and remand the case--even though the agency (like a new jury after a mistrial) might later, in the exercise of its lawful discretion, reach the same result for a different reason. [More Like This Headnote](#)

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HN17  Sound administrative procedure requires that the agency apply the law in accordance with statute and precedent. The agency tribunal must make findings of relevant facts, and present its reasoning in sufficient detail that the court may conduct meaningful review of the agency action. [More Like This Headnote](#)

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HN18  When agency reasoning is so crippled as to be unlawful, the court's practice is to vacate the agency's order, while when agency action is potentially lawful but insufficiently or inappropriately explained, the court frequently remands for further explanation (including discussion of the relevant factors and precedents) while withholding judgment on the lawfulness of the agency's proposed action. [More Like This Headnote](#)

COUNSEL: Richard H. Stern, of Washington, DC, argued for Sang Su Lee. With him on the brief was Robert E. Bushnell.

Sidney O. Johnson, Jr., Associate Solicitor, of Arlington, Virginia, argued for the Director of the U.S. Patent and Trademark Office. With him on the brief were John M. Whealan, Solicitor, and Raymond T. Chen, Associate Solicitor. Of counsel were Maximilian R. Peterson and Mark Nagumo, Associate Solicitors.

JUDGES: Before NEWMAN, CLEVINGER, and DYK, Circuit Judges.

OPINION BY: NEWMAN

OPINION:

[*1340] NEWMAN, Circuit Judge.

Sang-Su Lee appeals the decision of the Board of Patent Appeals and Interferences of the

United States Patent and Trademark Office, rejecting all of the claims of Lee's patent application Serial No. 07/631,210 entitled "Self-Diagnosis and Sequential-Display Method of Every Function." n1 We vacate the Board's decision for failure to meet the adjudicative standards for review under the Administrative Procedure Act, and remand for further proceedings.

- - - - - Footnotes - - - - -

n1 Ex parte Lee, No. 1994-1989 (Bd. Pat. App. & Int. Aug. 30, 1994; on reconsid'n Sept. 29, 1999).

- - - - - End Footnotes - - - - -

[2]**

The Prosecution Record

Mr. Lee's patent application is directed to a method of automatically displaying the functions of a video display device and demonstrating how to select and adjust the functions in order to facilitate response by the user. The display and demonstration are achieved using computer-managed electronics, including pulse-width modulation and auto-fine-tuning pulses, in accordance with procedures described in the specification. Claim 10 is representative:

10. A method for automatically displaying functions of a video display device, comprising:

determining if a demonstration mode is selected;

if said demonstration mode is selected, automatically entering a picture adjustment mode having a picture menu screen displaying a list of a plurality of picture functions; and

automatically demonstrating selection and adjustment of individual ones of said plurality of picture functions.

The examiner rejected the claims on the ground of obviousness, citing the combination of two references: United States Patent No. 4,626,892 to Nortrup, and the Thunderchopper Helicopter Operations **[*1341]** Handbook for a video game. The Nortrup reference describes a television **[**3]** set having a menu display by which the user can adjust various picture and audio functions; however, the Nortrup display does not include a demonstration of how to adjust the functions. The Thunderchopper Handbook describes the Thunderchopper game's video display as having a "demonstration mode" showing how to play the game; however, the Thunderchopper Handbook makes no mention of the adjustment of picture or audio functions. The examiner held that it would have been obvious to a person of ordinary skill to combine the teachings of these references to produce the Lee system.

Lee appealed to the Board, arguing that the Thunderchopper Handbook simply explained how to play the Thunderchopper game, and that the prior art provided no teaching or motivation or suggestion to combine this reference with Nortrup, or that such combination would produce the Lee invention. The Board held that it was not necessary to present a source of a

teaching, suggestion, or motivation to combine these references or their teachings. The Board stated:

The conclusion of obviousness may be made from common knowledge and common sense of a person of ordinary skill in the art without any specific hint or **[**4]** suggestion in a particular reference.

Board op. at 7. The Board did not explain the "common knowledge and common sense" on which it relied for its conclusion that "the combined teachings of Nortrup and Thunderchopper would have suggested the claimed invention to those of ordinary skill in the art."

Lee filed a request for reconsideration, to which the Board responded after five years. The Board reaffirmed its decision, stating that the Thunderchopper Handbook was "analogous art" because it was "from the same field of endeavor" as the Lee invention, and that the field of video games was "reasonably pertinent" to the problem of adjusting display functions because the Thunderchopper Handbook showed video demonstrations of the "features" of the game. On the matter of motivation to combine the Nortrup and Thunderchopper references, the Board stated that "we maintain the position that we stated in our prior decision" and that the Examiner's Answer provided "a well reasoned discussion of why there is sufficient motivation to combine the references." The Board did not state the examiner's reasoning, and review of the Examiner's Answer reveals that the examiner merely stated that both **[**5]** the Nortrup function menu and the Thunderchopper demonstration mode are program features and that the Thunderchopper mode "is user-friendly" and it functions as a tutorial, and that it would have been obvious to combine them.

Lee had pressed the examiner during prosecution for some teaching, suggestion, or motivation in the prior art to select and combine the references that were relied on to show obviousness. The Examiner's Answer before the Board, plus a Supplemental Answer, stated that the combination of Thunderchopper with Nortrup "would have been obvious to one of ordinary skill in the art since the demonstration mode is just a programmable feature which can be used in many different devices for providing automatic introduction by adding the proper programming software," and that "another motivation would be that the automatic demonstration mode is user friendly and it functions as a tutorial." The Board adopted the examiner's answer, stating "the examiner has provided a well reasoned discussion of these references and how the combination of these references meets the claim limitations." However, perhaps recognizing that the examiner had provided insufficient justification to **[**6]** **[*1342]** support combining the Nortrup and Thunderchopper references, the Board held, as stated supra, that a "specific hint or suggestion" of motivation to combine was not required.

This appeal followed.

Judicial Review

HN1 ¶ Tribunals of the PTO are governed by the Administrative Procedure Act, and their rulings receive the same judicial deference as do tribunals of other administrative agencies. Dickinson v. Zurko, 527 U.S. 150, 50 U.S.P.Q.2D (BNA) 1930, 144 L. Ed. 2d 143, 119 S. Ct. 1816 (1999). Thus on appeal we review a PTO Board's findings and conclusions in accordance with the following criteria:

5 U.S.C. § 706(2) **HN2** ¶ The reviewing court shall--

(2) hold unlawful and set aside agency actions, findings, and conclusions found to

be--

(A) arbitrary, capricious, an abuse of discretion, or otherwise not in accordance with law;

(E) unsupported by substantial evidence in a case subject to sections 556 and 557 of this title or otherwise reviewed on the record of an agency hearing provided by statute;

HN3 For judicial review to be meaningfully achieved within these strictures, the agency tribunal must present a full and reasoned **[**7]** explanation of its decision. The agency tribunal must set forth its findings and the grounds thereof, as supported by the agency record, and explain its application of the law to the found facts. The Court has often explained:

The Administrative Procedure Act, which governs the proceedings of administrative agencies and related judicial review, establishes a scheme of "reasoned decisionmaking." Not only must an agency's decreed result be within the scope of its lawful authority, but the process by which it reaches that result must be logical and rational.

Allentown Mack Sales and Service, Inc. v. National Labor Relations Bd., 522 U.S. 359, 374, 139 L. Ed. 2d 797, 118 S. Ct. 818 (1998) (citation omitted). This standard requires that the agency not only have reached a sound decision, but have articulated the reasons for that decision. The reviewing court is thus enabled to perform meaningful review within the strictures of the APA, for the court will have a basis on which to determine "whether the decision was based on the relevant factors and whether there has been a clear error of judgment." Citizens to Preserve Overton Park v. Volpe, 401 U.S. 402, 416, 28 L. Ed. 2d 136, 91 S. Ct. 814 (1971). **[**8]** **HN4** Judicial review of a Board decision denying an application for patent is thus founded on the obligation of the agency to make the necessary findings and to provide an administrative record showing the evidence on which the findings are based, accompanied by the agency's reasoning in reaching its conclusions. See In re Zurko, 258 F.3d 1379, 1386, 59 U.S.P.Q.2D (BNA) 1693, 1697 (Fed. Cir. 2001) (review is on the administrative record); In re Gartside, 203 F.3d 1305, 1314, 53 U.S.P.Q.2D (BNA) 1769, 1774 (Fed. Cir. 2000) (Board decision "must be justified within the four corners of the record").

HN5 As applied to the determination of patentability vel non when the issue is obviousness, "it is fundamental that rejections under 35 U.S.C. § 103 must be based on evidence comprehended by the language of that section." In re Grasselli, 713 F.2d 731, 739, 218 U.S.P.Q. (BNA) 769, 775 (Fed. Cir. 1983). The essential factual evidence on the issue of obviousness is set forth in Graham v. John Deere Co., 383 U.S. 1, 17-18, 148 U.S.P.Q. (BNA) 459, 467, 15 L. Ed. 2d 545, 86 S. Ct. 684 (1966) and extensive ensuing precedent. **HN6** The patent examination **[*1343]** process **[**9]** centers on prior art and the analysis thereof. When patentability turns on the question of obviousness, the search for and analysis of the prior art includes evidence relevant to the finding of whether there is a teaching, motivation, or suggestion to select and combine the references relied on as evidence of obviousness. See, e.g., McGinley v. Franklin Sports, Inc., 262 F.3d 1339, 1351-52, 60 U.S.P.Q.2D (BNA) 1001, 1008 (Fed. Cir. 2001) ("the central question is whether there is reason to combine

[the] references," a question of fact drawing on the Graham factors).

"The factual inquiry whether to combine references must be thorough and searching." *Id.* It must be based on objective evidence of record. This precedent has been reinforced in myriad decisions, and cannot be dispensed with. See, e.g., Brown & Williamson Tobacco Corp. v. Philip Morris Inc., 229 F.3d 1120, 1124-25, 56 U.S.P.Q.2D (BNA) 1456, 1459 (Fed. Cir. 2000) ("a showing of a suggestion, teaching, or motivation to combine the prior art references is an 'essential component of an obviousness holding'") (quoting C.R. Bard, Inc., v. M3 Systems, Inc., 157 F.3d 1340, 1352, 48 U.S.P.Q.2D (BNA) 1225, 1232 (Fed. Cir. 1998)); **[**10]** In re Dembiczak, 175 F.3d 994, 999, 50 U.S.P.Q.2D (BNA) 1614, 1617 (Fed. Cir. 1999) ("Our case law makes clear that the best defense against the subtle but powerful attraction of a hindsight-based obviousness analysis is rigorous application of the requirement for a showing of the teaching or motivation to combine prior art references."); In re Dance, 160 F.3d 1339, 1343, 48 U.S.P.Q.2D (BNA) 1635, 1637 (Fed. Cir. 1998) (there must be some motivation, suggestion, or teaching of the desirability of making the specific combination that was made by the applicant); In re Fine, 837 F.2d 1071, 1075, 5 U.S.P.Q.2D (BNA) 1596, 1600 (Fed. Cir. 1988) ("teachings of references can be combined only if there is some suggestion or incentive to do so.") (emphasis in original) (quoting ACS Hosp. Sys., Inc. v. Montefiore Hosp., 732 F.2d 1572, 1577, 221 U.S.P.Q. (BNA) 929, 933 (Fed. Cir. 1984)).

The need for specificity pervades this authority. See, e.g., In re Kotzab, 217 F.3d 1365, 1371, 55 U.S.P.Q.2D (BNA) 1313, 1317 (Fed. Cir. 2000) ("particular findings must be made as to the reason the skilled artisan, with no knowledge of the claimed invention, **[**11]** would have selected these components for combination in the manner claimed"); In re Rouffet, 149 F.3d 1350, 1359, 47 U.S.P.Q.2D (BNA) 1453, 1459 (Fed. Cir. 1998) ^{HN7} ("even when the level of skill in the art is high, the Board must identify specifically the principle, known to one of ordinary skill, that suggests the claimed combination. In other words, the Board must explain the reasons one of ordinary skill in the art would have been motivated to select the references and to combine them to render the claimed invention obvious."); In re Fritch, 972 F.2d 1260, 1265, 23 U.S.P.Q.2D (BNA) 1780, 1783 (Fed. Cir. 1992) (the examiner can satisfy the burden of showing obviousness of the combination "only by showing some objective teaching in the prior art or that knowledge generally available to one of ordinary skill in the art would lead that individual to combine the relevant teachings of the references").

With respect to Lee's application, neither the examiner nor the Board adequately supported the selection and combination of the Nortrup and Thunderchopper references to render obvious that which Lee described. The examiner's conclusory statements that "the demonstration mode **[**12]** is just a programmable feature which can be used in many different devices for providing automatic introduction by adding the proper programming software" and that "another motivation would be that the automatic demonstration mode is user friendly and it functions as a tutorial" do not adequately address the issue of motivation to combine. ^{HN8} This factual question **[*1344]** of motivation is material to patentability, and could not be resolved on subjective belief and unknown authority. It is improper, in determining whether a person of ordinary skill would have been led to this combination of references, simply to "[use] that which the inventor taught against its teacher." W.L. Gore v. Garlock, Inc., 721 F.2d 1540, 1553, 220 U.S.P.Q. (BNA) 303, 312-13 (Fed. Cir. 1983). Thus the Board must not only assure that the requisite findings are made, based on evidence of record, but must also explain the reasoning by which the findings are deemed to support the agency's conclusion.

^{HN9} Deferential judicial review under the Administrative Procedure Act does not relieve the agency of its obligation to develop an evidentiary basis for its findings. To the contrary, the Administrative Procedure Act reinforces **[**13]** this obligation. See, e.g., Motor Vehicle

Manufacturers Ass'n v. State Farm Mutual Automobile Ins. Co., 463 U.S. 29, 43, 77 L. Ed. 2d 443, 103 S. Ct. 2856 (1983) ("the agency must examine the relevant data and articulate a satisfactory explanation for its action including a 'rational connection between the facts found and the choice made.'") (quoting Burlington Truck Lines v. United States, 371 U.S. 156, 168, 9 L. Ed. 2d 207, 83 S. Ct. 239 (1962)); Securities & Exchange Comm'n v. Chenery Corp., 318 U.S. 80, 94, 87 L. Ed. 626, 63 S. Ct. 454 (1943) ("The orderly function of the process of review requires that the grounds upon which the administrative agency acted are clearly disclosed and adequately sustained.").

In its decision on Lee's patent application, the Board rejected the need for "any specific hint or suggestion in a particular reference" to support the combination of the Nortrup and Thunderchopper references. ^{HN10} Omission of a relevant factor required by precedent is both legal error and arbitrary agency action. See Motor Vehicle Manufacturers, 463 U.S. at 43 ("an agency rule would be arbitrary and **[**14]** capricious if the agency . . . entirely failed to consider an important aspect of the problem"); Mullins v. Department of Energy, 50 F.3d 990, 992 (Fed. Cir. 1995) ("It is well established that agencies have a duty to provide reviewing courts with a sufficient explanation for their decisions so that those decisions may be judged against the relevant statutory standards, and that failure to provide such an explanation is grounds for striking down the action."). As discussed in National Labor Relations Bd. v. Ashkenazy Property Mgt. Corp., 817 F.2d 74, 75 (9th Cir. 1987), an agency is "not free to refuse to follow circuit precedent."

The foundation of the principle of judicial deference to the rulings of agency tribunals is that the tribunal has specialized knowledge and expertise, such that when reasoned findings are made, a reviewing court may confidently defer to the agency's application of its knowledge in its area of expertise. ^{HN11} Reasoned findings are critical to the performance of agency functions and judicial reliance on agency competence. See Baltimore and Ohio R. R. Co. v. Aberdeen & Rockfish R. R. Co., 393 U.S. 87, 91-92, 21 L. Ed. 2d 219, 89 S. Ct. 280 (1968) **[**15]** (absent reasoned findings based on substantial evidence effective review would become lost "in the haze of so-called expertise"). The "common knowledge and common sense" on which the Board relied in rejecting Lee's application are not the specialized knowledge and expertise contemplated by the Administrative Procedure Act. Conclusory statements such as those here provided do not fulfill the agency's obligation. This court explained in Zurko, 258 F.3d at 1385, 59 U.S.P.Q.2D (BNA) at 1697, that ^{HN12} "deficiencies of the cited references cannot be remedied by the Board's general conclusions about what is 'basic knowledge' or 'common sense.'" The **[*1345]** Board's findings must extend to all material facts and must be documented on the record, lest the "haze of so-called expertise" acquire insulation from accountability. "Common knowledge and common sense," even if assumed to derive from the agency's expertise, do not substitute for authority when the law requires authority. See Allentown Mack, 522 U.S. at 376 ("Because reasoned decisionmaking demands it, and because the systemic consequences of any other approach are unacceptable, the Board must be required to apply in fact the **[**16]** clearly understood legal standards that it enunciates in principle")

The case on which the Board relies for its departure from precedent, In re Bozek, 57 C.C.P.A. 713, 416 F.2d 1385, 163 U.S.P.Q. (BNA) 545 (CCPA 1969), indeed mentions "common knowledge and common sense," the CCPA stating that the phrase was used by the Solicitor to support the Board's conclusion of obviousness based on evidence in the prior art. Bozek did not hold that common knowledge and common sense are a substitute for evidence, but only that they ^{HN13} may be applied to analysis of the evidence. Bozek did not hold that objective analysis, proper authority, and reasoned findings can be omitted from Board decisions. Nor does Bozek, after thirty-two years of isolation, outweigh the dozens of rulings of the Federal Circuit and the Court of Customs and Patent Appeals that ^{HN14} "determination of patentability must be based on evidence. This court has remarked, in Smiths Industries Medical Systems, Inc. v. Vital Signs, Inc., 183 F.3d 1347, 1356, 51 U.S.P.Q.2D (BNA) 1415,

1421 (Fed. Cir. 1999), that Bozek's reference to common knowledge "does not in and of itself make it so" absent evidence **[**17]** of such knowledge.

The determination of patentability on the ground of unobviousness is ultimately one of judgment. In furtherance of the judgmental process, the patent examination procedure serves both to find, and to place on the official record, that which has been considered with respect to patentability. ^{HN15} The patent examiner and the Board are deemed to have experience in the field of the invention; however, this experience, insofar as applied to the determination of patentability, must be applied from the viewpoint of "the person having ordinary skill in the art to which said subject matter pertains," the words of section 103. In finding the relevant facts, in assessing the significance of the prior art, and in making the ultimate determination of the issue of obviousness, the examiner and the Board are presumed to act from this viewpoint. Thus when they rely on what they assert to be general knowledge to negate patentability, that knowledge must be articulated and placed on the record. The failure to do so is not consistent with either effective administrative procedure or effective judicial review. The board cannot rely on conclusory statements when dealing with particular combinations **[**18]** of prior art and specific claims, but must set forth the rationale on which it relies.

Alternative Grounds

At oral argument the PTO Solicitor proposed alternative grounds on which this court might affirm the Board's decision. However, as stated in Burlington Truck Lines, Inc. v. United States, 371 U.S. 156, 168, 9 L. Ed. 2d 207, 83 S. Ct. 239 (1962), ^{HN16} "courts may not accept appellate counsel's post hoc rationalization for agency action." Consideration by the appellate tribunal of new agency justifications deprives the aggrieved party of a fair opportunity to support its position; thus review of an administrative decision must be made on the grounds relied on by the agency. "If those grounds are inadequate or improper, the court is powerless to affirm the administrative action by substituting what it considers **[*1346]** to be a more adequate or proper basis." Securities & Exchange Comm'n v. Chenery Corp., 332 U.S. 194, 196, 91 L. Ed. 1995, 67 S. Ct. 1575 (1947). As reiterated in Federal Election Comm'n v. Akins, 524 U.S. 11, 25, 118 S. Ct. 1777, 141 L. Ed. 2d 10 (1998), "If a reviewing court agrees that the agency misinterpreted the law, it will set aside the **[**19]** agency's action and remand the case -- even though the agency (like a new jury after a mistrial) might later, in the exercise of its lawful discretion, reach the same result for a different reason." Thus we decline to consider alternative grounds that might support the Board's decision.

Further Proceedings

^{HN17} Sound administrative procedure requires that the agency apply the law in accordance with statute and precedent. The agency tribunal must make findings of relevant facts, and present its reasoning in sufficient detail that the court may conduct meaningful review of the agency action. In Radio-Television News Directors Ass'n v. FCC, 337 U.S. App. D.C. 292, 184 F.3d 872 (D.C. Cir. 1999) the court discussed the "fine line between agency reasoning that is 'so crippled as to be unlawful' and action that is potentially lawful but insufficiently or inappropriately explained," quoting from Checkosky v. Securities & Exch. Comm'n, 306 U.S. App. D.C. 144, 23 F.3d 452, 464 (D.C. Cir. 1994); the court explained that ^{HN18} "in the former circumstance, the court's practice is to vacate the agency's order, while in the latter the court frequently remands for further explanation **[**20]** (including discussion of the relevant factors and precedents) while withholding judgment on the lawfulness of the agency's proposed action." 184 F.3d at 888. In this case the Board's analysis of the Lee invention does not comport with either the legal requirements for determination of obviousness or with the requirements of the Administrative Procedure Act that the agency tribunal set forth the findings and explanations needed for "reasoned decisionmaking."

Remand for these purposes is required. See Overton Park, 401 U.S. at 420-221 (remanding for further proceedings appropriate to the administrative process).

VACATED AND REMANDED

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Citation: **972 f2d 1260**

*972 F.2d 1260, *; 1992 U.S. App. LEXIS 18470, **;
23 U.S.P.Q.2D (BNA) 1780; 92 Daily Journal DAR 11427*

IN RE JOHN R. FRITCH

91-1318

UNITED STATES COURT OF APPEALS FOR THE FEDERAL CIRCUIT

972 F.2d 1260; 1992 U.S. App. LEXIS 18470; 23 U.S.P.Q.2D (BNA) 1780; 92 Daily Journal
DAR 11427

August 11, 1992, Decided

PRIOR HISTORY: **[**1]** Appealed from: U.S. Patent and Trademark Office Board of
Patent Appeals and Interferences

DISPOSITION: REVERSED

CASE SUMMARY


PROCEDURAL POSTURE: Appellant sought review of the decision of the U.S. Patent
and Trademark Office Board of Patent Appeals and Interferences affirming the decision
that appellant's invention would have been obvious to one of ordinary skill in the art and
was therefore unpatentable under 35 U.S.C.S. § 103.


OVERVIEW: Appellant sought a patent for an invention intended to be used as a
landscape fill retainer. The examiner rejected appellant's application, concluding that the
invention would have been obvious to one of ordinary skill in the art and was
unpatentable under 35 U.S.C.S. § 103. Prior art included the Wilson Patent, intended to
be used adjacent to sidewalk borders and flower beds, and the Hendrix Patent, intended
to be used to retain gravel in driveways. The board affirmed. The court reversed, holding
that there was no teaching, suggestion, or incentive in the prior art to modify or to
combine the teachings of the prior art in the manner suggested by the examiner;
obviousness could not be established by combining the teachings of the prior art to
produce the claimed invention, absent some teaching or suggestion supporting the
combination; and the examiner relied on hindsight in determination of obviousness.

OUTCOME: The court reversed, holding that it was impermissible to use appellant's
claimed invention as an instruction manual to piece together the teachings of the prior
art, thus rendering a determination that the claimed invention was obvious.

CORE TERMS: strip, teaching, surface, flexible, retainer, invention, extending, leg,
conformable, anchoring, patent, thin, obviousness, varying, slope, landscape, entirety,
planar, mower, gauge, skill, bottom, mowing, edging, longitudinally, longitudinal, flexibility,
elongate, modification, subject matter

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[Patent Law](#) > [Nonobviousness](#) > [Tests & Proof of Obviousness](#) 


[Patent Law](#) > [Jurisdiction & Review](#) > [Standards of Review](#) 

HN1 Obviousness is a question of law to be determined from the facts. The obviousness


A47

determination is based upon underlying factual inquiries concerning the claimed invention and the prior art, which are reviewed for clear error. However, it is the ultimate conclusion of obviousness that the Federal Circuit reviews as a matter of law. [More Like This Headnote](#)


Patent Law > Novelty & Anticipation 

HN2  It is well settled that a prior art reference is relevant for all that it teaches to those of ordinary skill in the art. [More Like This Headnote](#)


Patent Law > Nonobviousness > Tests & Proof of Obviousness 

HN3  In proceedings before the United States Patent and Trademark Office, the examiner bears the burden of establishing a prima facie case of obviousness based upon the prior art. The examiner can satisfy this burden only by showing some objective teaching in the prior art or that knowledge generally available to one of ordinary skill in the art would lead that individual to combine the relevant teachings of the references. The patent applicant may then attack the examiner's prima facie determination as improperly made out, or the applicant may present objective evidence tending to support a conclusion of nonobviousness. [More Like This Headnote](#)


Patent Law > Nonobviousness > Tests & Proof of Obviousness 

HN4  Obviousness cannot be established by combining the teachings of the prior art to produce the claimed invention, absent some teaching or suggestion supporting the combination. Under 35 U.S.C. § 103, teachings of references can be combined only if there is some suggestion or incentive to do so. Although couched in terms of combining teachings found in the prior art, the same inquiry must be carried out in the context of a purported obvious "modification" of the prior art. The mere fact that the prior art may be modified in the manner suggested by the examiner does not make the modification obvious unless the prior art suggested the desirability of the modification. [More Like This Headnote](#)

Patent Law > Nonobviousness > Tests & Proof of Obviousness 

HN5  It is impermissible to use the claimed invention as an instruction manual or "template" to piece together the teachings of the prior art so that the claimed invention is rendered obvious. One cannot use hindsight reconstruction to pick and choose among isolated disclosures in the prior art to deprecate the claimed invention. [More Like This Headnote](#)

Patent Law > Nonobviousness > Tests & Proof of Obviousness 

HN6  Dependent claims are nonobvious if the independent claims from which they depend are nonobvious. [More Like This Headnote](#)

COUNSEL: Charles L. Gholz, Oblon, Spivak, McClelland, Maier, et al, of Arlington, Virginia, argued for appellant. John R. Fritch, of Corpus Christi, Texas, was on the brief.

Jameson Lee, Associate Solicitor, Office of the Solicitor, of Arlington, Virginia, argued for appellee. With him on the brief was Fred E. McKelvey, Solicitor. Of counsel was Richard E. Schafer.

JUDGES: Before PLAGER, Circuit Judge, SMITH, Senior Circuit Judge, and RADER, Circuit Judge.

OPINION BY: SMITH

OPINION: [*1261] SMITH, Senior Circuit Judge.

John R. Fritch (Fritch) appeals the 27 February 1991 decision of the Patent and Trademark Office Board of Patent Appeals and Interferences (Board) affirming-in-part the Examiner's final rejection of the remaining claims in Fritch's application entitled Landscape Edging Apparatus and Method. n1 The Examiner concluded that Fritch's invention would have been obvious to one of ordinary skill in the art and was therefore unpatentable under 35 U.S.C. § 103. The Board, except for allowing claim 28, agreed. The Board's decision is reversed.

- - - - - Footnotes - - - - -

n1 Serial No. 06/838,721.

- - - - - End Footnotes - - - - - **[**2]**

Issue

The issue is whether the Board erred in affirming the Examiner's determination that the prior art references of Wilson and Hendrix rendered the subject matter of Fritch's independent claims 1, 13, 24, and 29 obvious to one of ordinary skill in the art.

Background

In his final rejection, the Examiner rejected claims 1-24 and 27-30 of Fritch's application as unpatentable for obviousness under 35 U.S.C. § 103. Fritch appealed the final rejection to the Board. The Board affirmed the rejection as to claims 1-24, 29 and 30, entered a new ground of rejection for claim 27, and reversed as to claim 28. The Board agreed with the Examiner that the teachings of the Wilson and Hendrix patents rendered the subject matter of independent claims 1, 13, 24, and 29 obvious to one of ordinary skill in the art. Fritch does not appeal the Board's disposition as to claims 27 and 28, and at oral argument withdrew the appeal as to claim 8. The claims remaining in this appeal are 1-7, 9-24, 29 and 30.

The Fritch Invention

The invention claimed by Fritch involves a landscape edging device which includes a planar base portion and an upwardly extending retainer portion. The base portion **[**3]** is elongate, thin, flexible and has a planar bottom surface conformable to a varying slope ground surface. One longitudinal **[*1262]** edge of the base portion serves as a mowing strip and the other serves as a retaining flange for landscape fill. The upwardly extending retainer portion is integrally connected (e.g., fused) to the base portion and defines a longitudinally extending enclosed space. The Fritch invention is intended to be used as a retainer for landscape fill in order to separate unmowable landscape fill from the mowable lawn. It may also be used to secure a landscaping sheet to the ground, or to function as guards at the base of a fence. Independent claims 1 and 13 on appeal are representative of the subject matter claimed:

1. A landscape edging strip formed in its entirety of a thin gauge, flexible material and conformable to a ground surface of varying slope, comprising a continuous elongate, thin gauge, flexible base portion having a planar bottom surface conformable to said varying slope ground surface; a thin gauge, elongate retainer portion integral with said base portion and extending upwardly therefrom and transversely thereover to overlie a portion of said base portion; **[**4]** all of said retainer portion defining a longitudinally extending enclosed space; said retainer portion being integrally connected to said base portion adjacent one longitudinal edge of said base portion to define a mowing strip adjacent the other longitudinal

edge of said base portion.

* * * *

13. A landscape edging strip formed in its entirety from thin gauge, flexible material and conformable to a ground surface of varying slope, comprising a continuous elongate, thin gauge, flexible base portion having a planar bottom surface conformable to said varying slope ground surface; a thin gauge, elongate retainer portion integral with said base portion and extending upwardly therefrom and transversely thereover to overlie a portion of said base portion; all of said retainer portion defining a longitudinally extending enclosed space; said retainer portion being integrally connected to said base portion at a transverse location between the longitudinal edges of said base portion, thereby defining a longitudinally extending retaining flange on one side of said retainer portion and a mowing strip on the other side of said retainer portion.

* * * *

The critical language in Fritch's Independent **[**5]** claims is that the device is to be, in its entirety, both flexible and "conformable to a ground surface of varying slope". These limitations, although located in the claims' preambles, "are necessary to give meaning to the claim[s] and properly define the invention". n2 Figure 1 from Fritch's drawings is reproduced below:

[SEE FIG. 1 IN ORIGINAL]

----- Footnotes -----

n2 Perkin Elmer Corp. v. Computervision Corp., 732 F.2d 888, 896, 221 USPQ 669, 675 (Fed. Cir. 1984).

----- End Footnotes -----

[*1263] *The Prior Art*

a. *The Wilson Patent*

The Wilson patent relied upon by the Examiner and the Board is entitled "Grass Edging and Watering Device". n3 The embodiment of the Wilson device includes a substantially flat mowing strip extending horizontally from a longitudinally extending body portion. Opposite the mowing strip is a scored flange which may be broken off when not needed or wanted. Between the mowing strip and the flange, and extending vertically from the body portion is an anchoring leg. Located above the anchoring leg is the **[**6]** body portion which contains a water conduit and sprinkler head assembly. The device is intended to be used adjacent to the borders of walks and plant beds. Figures 1 and 4 from Wilson's drawings are reproduced below:

[SEE FIG. 1 IN ORIGINAL]

[SEE FIG. 4 IN ORIGINAL]

----- Footnotes -----

n3 U.S. Patent No. 3,485,449.

A50

----- End Footnotes-----

b. The Hendrix Patent

The Hendrix patent is entitled "Loose Material Retainer Strip". n4 The Solicitor chose not to discuss the Hendrix reference in his brief, stating that the Board had deemed Hendrix unnecessary to its decision. The Solicitor overstates the Board's position. The Board based its decision upon "a collective evaluation of the Wilson and Hendrix patents". We include Hendrix in our discussion because it did play a role in the rejection of Fritch's independent claims.

----- Footnotes-----

n4 U.S. Patent No. 4,349,596.

----- End Footnotes-----

The Hendrix device is composed of elongated, **[**7]** flexible strips having substantially C-shaped cross-section. The bottom lip of the device is to be wider than the top lip in order to facilitate fastening the device to the ground. The device will fit most gentle contours, and the top lip will yield laterally to build-up of gravel until the gravel can be redistributed. The concave portion of the strip is installed such that it faces the material to be retained in place. Hendrix contemplates that the retainer will be used in retaining gravel in driveways, lining flower beds, or on the shoulders of asphalt or concrete highways. Figure 1 of Hendrix's drawings is reproduced below:

[*1264] [SEE FIG. 1 IN ORIGINAL]

Standard of Review

HN1 "Obviousness is a question of law to be determined from the facts." n5 The obviousness determination "is based upon underlying factual inquiries concerning the claimed invention and the prior art" which are reviewed for clear error. n6 However, it is the ultimate conclusion of obviousness which the Federal Circuit reviews as a matter of law. n7

----- Footnotes-----

n5 In re De Blauwe, 736 F.2d 699, 703, 222 USPQ 191, 195 (Fed. Cir. 1984). **[**8]**

n6 In re Kulling, 897 F.2d 1147, 1149, 14 USPQ2d 1056, 1057 (Fed. Cir. 1990).

n7 In re De Blauwe, 736 F.2d at 703, 222 USPQ at 195.

----- End Footnotes-----

Teachings of Wilson

Fritch takes exception to the Examiner's findings of fact related to the teachings of the Wilson

patent. The Examiner's rejection and the Board's opinion rely heavily on the use of Wilson in view of other references to declare the Fritch invention obvious. The Board states that it agrees with the Examiner's finding of fact regarding the teachings of Wilson. In the Examiner's answer, which the Board quotes, the Wilson device is described as follows:

Wilson discloses a landscaping edging strip comprising a relatively thin gauge, elongated flexible base portion including a mower strip B having a planar bottom surface conformable to a varying slope surface.

The Board states that the Wilson reference presents "substantial evidence that Wilson is both thin and flexible." The Board regards the Wilson device as teaching that it is flexible and conformable in its entirety. This **[**9]** finding demonstrates clear error.

HN2 It is well settled that a prior art reference is relevant for all that it teaches to those of ordinary skill in the art. n8 The base portion of Wilson is not planar in its **[*1265]** entirety, as the Board's opinion suggests, but also includes a prominent anchoring leg to secure the device to the ground. The anchoring leg, which runs the length of the Wilson device, would inhibit longitudinal flexibility of the Wilson device. Indeed, Wilson expressly contemplates flexibility and conformability only in the mower strip. Wilson states that its mower strip may be lifted in order to pack dirt thereunder for the purpose of securing the device to the ground. Fritch, on the other hand, is claimed to be flexible in its entirety. The Board's holding that Wilson is flexible in its entirety is based upon a misapprehension of the scope of Wilson's teachings.

----- Footnotes -----

n8 *Beckman Instruments Inc. v. LKB Produkter AB*, 892 F.2d 1547, 1551, 13 USPQ2d 1301, 1304 (Fed. Cir. 1989).

----- End Footnotes -----

Second, **[**10]** Wilson's anchoring leg prohibits conformability to the ground surface in the manner claimed by Fritch. The Examiner's description of Wilson as having a "planar bottom surface conformable to a varying slope surface" is applicable only in reference to the mower strip. This description, however, ignores the anchor leg and the fact that it must be placed into the ground. Wilson expressly teaches that the anchoring leg may be pushed into soft soils, but in harder terrain a trench is needed in order to place the Wilson sprinkler system. In order to install the Wilson apparatus, the ground surface must be altered to conform to the device rather than, as the Solicitor contends, that Wilson is freely conformable to the ground. Fritch, on the other hand, does not require such extensive alteration of the ground surface in order to install the device.

Prima Facie Obviousness

HN3 In proceedings before the Patent and Trademark Office, the Examiner bears the burden of establishing a prima facie case of obviousness based upon the prior art. n9 "[The Examiner] can satisfy this burden only by showing some objective teaching in the prior art or that knowledge generally available to one of ordinary **[**11]** skill in the art would lead that individual to combine the relevant teachings of the references." n10 The patent applicant may then attack the Examiner's prima facie determination as improperly made out, or the applicant may present objective evidence tending to support a conclusion of nonobviousness. n11

----- Footnotes -----

n9 *In re Plasecki*, 745 F.2d 1468, 1471-72, 223 USPQ 785, 787-88 (Fed. Cir. 1984).

n10 *In re Fine*, 837 F.2d 1071, 1074, 5 USPQ2d 1596, 1598 (Fed. Cir. 1988) (citing *In re Lahu*, 747 F.2d 703, 705, 223 USPQ 1257, 1258 (Fed. Cir. 1988)).

n11 *In re Heldt*, 58 C.C.P.A. 701, 433 F.2d 808, 811, 167 USPQ 676, 678 (CCPA 1970).

----- End Footnotes-----

Fritch has attacked the Board's finding that the Examiner established that Fritch's claimed invention was prima facie obvious in view of the teachings of the prior art. The Board states that "a collective evaluation of the Wilson and the Hendrix patents would have rendered the subject **[**12]** matter of independent claims 1, 13, 24, and 29 obvious to one of ordinary skill." Fritch maintains that there is no teaching, suggestion, or incentive in the prior art to modify or to combine the teachings of the prior art in the manner suggested by the Examiner. We agree.

Wilson teaches a grass edging and watering device which includes an anchoring leg for securing the device to the ground. Wilson contemplates that a trench will need to be dug in order to allow the anchoring leg to be placed into the ground if the condition of the soil requires it. This anchoring leg prohibits flexibility and conformability over the length of Wilson. Any flexibility or conformability in Wilson, which the Board states extends to the entire device, is limited to the mower strip. It is only the mower strip that is mentioned as being flexible in order to aid installation. Hendrix has been cited for its teaching of a flexible retainer strip that is able to conform to the ground surface.

Wilson addresses the problems of arresting growth of grass between areas and watering plants without wetting sidewalks. Wilson lacks any suggestion or incentive to use its water conduit as a landscape retainer since this **[**13]** would arguably result in clogged sprinkler heads. n12 Wilson also **[*1266]** teaches that its mower strip is flexible in order to allow dirt to be packed thereunder. There is no suggestion in Wilson to extend that flexibility to the entire device. Wilson also lacks any teaching or suggestion that one should remove the anchoring leg. Hendrix does not, simply by virtue of its flexible nature, suggest these extensive changes which the Board states are obvious. Neither Wilson nor Hendrix, alone or in combination, provide any incentive to combine the teachings of the prior art in the manner maintained by the Board.

----- Footnotes -----

n12 This court has previously found a proposed modification inappropriate for an obviousness inquiry when the modification rendered the prior art reference inoperable for its intended purpose. *In re Gordon*, 733 F.2d 900, 902, 221 USPQ 1125, 1127 (Fed. Cir. 1984).

-----End Footnotes----- HN47

"Obviousness cannot be established by combining the teachings of the prior art to produce the claimed invention, absent some teaching **[**14]** or suggestion supporting the combination. Under section 103, teachings of references can be combined *only* if there is some suggestion or incentive to do so." n13 Although couched in terms of combining teachings found in the prior art, the same inquiry must be carried out in the context of a

purported obvious "modification" of the prior art. The mere fact that the prior art may be modified in the manner suggested by the Examiner does not make the modification obvious unless the prior art suggested the desirability of the modification. n14 Wilson and Hendrix fail to suggest any motivation for, or desirability of, the changes espoused by the Examiner and endorsed by the Board.

----- Footnotes -----

n13 ACS Hosp. Systems, Inc. v. Montefiore Hosp., 732 F.2d 1572, 1577, 221 USPQ 929, 933 (Fed. Cir. 1984).

n14 In re Gordon, 733 F.2d at 902, 221 USPQ at 1127.

----- End Footnotes-----

Here, the Examiner relied upon hindsight to arrive at the determination of obviousness. ^{HN5} ¶ It is impermissible to use [****15**] the claimed invention as an instruction manual or "template" to pieced together the teachings of the prior art so that the claimed invention is rendered obvious. n15 This court has previously stated that "one cannot use hindsight reconstruction to pick and choose among isolated disclosures in the prior art to deprecate the claimed invention." n16

----- Footnotes -----

n15 In re Gorman, 933 F.2d 982, 987, 18 USPQ2d 1885, 1888 (Fed. Cir. 1991). See also Interconnect Planning Corp. v. Feil, 774 F.2d 1132, 1138, 227 USPQ 543, 547 (Fed. Cir. 1985).

n16 In re Fine, 837 F.2d at 1075, 5 USPQ2d at 1600.

----- End Footnotes-----

Conclusion

The decision of the Board affirming the Examiner's rejection of independent claims 1, 13, 24, and 29 of Fritch's application as unpatentable over the prior art under 35 U.S.C. § 103 is reversed. Since ^{HN6} ¶ dependent claims are nonobvious if the independent claims from which they depend are nonobvious, the Board's affirmance of the [****16**] rejection of dependent claims 2-7, 9-12, 14-23, and 30 is also reversed. n17

----- Footnotes -----

n17 In re Fine, 837 F.2d at 1076, 5 USPQ2d at 1600 (citing Hartness Int'l, Inc. v. Simplimatic Eng'g Co., 819 F.2d 1100, 1108, 2 USPQ2d 1826, 1831 (Fed. Cir. 1987)). See also In re Sernaker, 702 F.2d 989, 991, 217 USPQ 1, 3 (Fed. Cir. 1983) (when argued together, dependent claims stand or fall with the independent claims from which they depend).

----- End Footnotes-----

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Citation: **732 f2d 1572**

*732 F.2d 1572, *; 1984 U.S. App. LEXIS 15027, **;
221 U.S.P.Q. (BNA) 929*

ACS HOSPITAL SYSTEMS, INC., Appellant/Cross-Appellee, v. MONTEFIORE HOSPITAL and
WELLS NATIONAL SERVICES CORPORATION, Appellees/Cross-Appellants

Appeal Nos. 83-1121, 83-1132

UNITED STATES COURT OF APPEALS FOR THE FEDERAL CIRCUIT

732 F.2d 1572; 1984 U.S. App. LEXIS 15027; 221 U.S.P.Q. (BNA) 929

April 27, 1984

PRIOR HISTORY: [1]**

Appealed from: U.S. District Court for the Western District of Pennsylvania.

DISPOSITION: Affirmed in Part and Reversed in Part.

CASE SUMMARY

PROCEDURAL POSTURE: Plaintiff patentee appealed a judgment entered by the United States District Court for the Western District of Pennsylvania, which held that its patent for a hospital television rental system was invalid due to obviousness and that it was not infringed by defendant, an alleged infringer.

OVERVIEW: The court reversed a judgment that held that the patentee's patent for a television rental system was invalid as obvious under 35 U.S.C.S. § 103. The district court's assessments of the scope and content of the prior art, the differences between the claimed subject matter and the prior art, and the level of ordinary skill in the art were clearly erroneous. None of the prior art references disclosed the use of override switches in a television rental system. Therefore, the judgment of invalidity was incorrect as a matter of law. Because the alleged infringer's system lacked the patentee's claimed limitation of override switches, a judgment that the alleged infringer did not infringe the patent, either literally or under the doctrine of equivalents, was not clearly erroneous and was affirmed.



OUTCOME: The court reversed the judgment, which held that the patentee's patent for a television rental system was invalid as obvious, because the judgment was incorrect as a matter of law. The court affirmed that part of the judgment that held that the alleged infringer's product did not infringe the patent either literally or under the doctrine of equivalents.


CORE TERMS: switch, patent, override, television, switching, actuated, invention, subject matter, rental, relay, actuating, normally, invalidity, invalid, obviousness, clearly erroneous, overriding, receiver, locked, skill, actuate, indicator, infringe, switched, infringement, enabling, matter of law, depressing, overridden, literally




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A55


[Patent Law](#) > [U.S. Patent & Trademark Office Prosecution Procedures](#) > [Continuation Applications](#) 
[Evidence](#) > [Procedural Considerations](#) > [Burdens of Proof](#) 


HN1  The presumption of patent validity under 35 U.S.C.S. § 282 is never annihilated, destroyed, or even weakened, regardless of what facts are of record. Rather, it is a clear statutory procedural device which assigns to the party asserting invalidity the burden of proving invalidity. The burden of persuasion is, and remains always, on the party asserting invalidity. [More Like This Headnote](#)


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[Patent Law](#) > [Infringement](#) > [Defenses](#) > [Invalidity](#) 
[Evidence](#) > [Procedural Considerations](#) > [Burdens of Proof](#) 


HN2  A patent shall be presumed valid. The burden of establishing invalidity of a patent or any claim thereof shall rest on the party asserting such invalidity. 35 U.S.C.S. § 282. [More Like This Headnote](#)


[Patent Law](#) > [Nonobviousness](#) > [Tests & Proof of Obviousness](#) 


HN3  35 U.S.C.S. § 103 lends itself to several basic factual inquiries. Under 35 U.S.C.S. § 103, the scope and content of the prior art are to be determined; differences between the prior art and the claims at issue are to be ascertained; and the level of ordinary skill in the pertinent art resolved. Against this background, the obviousness or non-obviousness of the subject matter is determined. Such secondary considerations as commercial success, long felt but unsolved needs, failure of others, etc., might be utilized to give light to the circumstances surrounding the origin of the subject matter sought to be patented. As indicia of obviousness or nonobviousness, these inquiries may have relevancy. [More Like This Headnote](#)


[Patent Law](#) > [Infringement](#) > [Claim Interpretation](#) 


HN4  Claims are to be read and construed in light of the specification and the prosecution history of the patent. Further, claims should be so construed, if possible, as to sustain their validity. [More Like This Headnote](#)


[Patent Law](#) > [Nonobviousness](#) > [Tests & Proof of Obviousness](#) 


HN5  Obviousness cannot be established by combining the teachings of the prior art to produce the claimed invention, absent some teaching or suggestion supporting the combination. Under 35 U.S.C.S. § 103, teachings of references can be combined only if there is some suggestion or incentive to do so. [More Like This Headnote](#)


[Patent Law](#) > [Infringement](#) > [Claim Interpretation](#) 

[Patent Law](#) > [Infringement](#) > [Acts of Infringement](#) 


HN6  Infringement is determined on the basis of the claims, not on the basis of a comparison with the patentee's commercial embodiment of the claimed invention. [More Like This Headnote](#)

[Civil Procedure](#) > [Appeals](#) > [Standards of Review](#) > [Clearly Erroneous Review](#) 

[Patent Law](#) > [Jurisdiction & Review](#) > [Standards of Review](#) 

HN7  Findings of fact are to be construed liberally in support of a judgment. [More Like This Headnote](#)


[Civil Procedure](#) > [Trials](#) > [Bench Trials](#) 


[Civil Procedure](#) > [Appeals](#) > [Standards of Review](#) > [Clearly Erroneous Review](#) 

HN8  Where the trial court fails to make findings, the judgment will normally be vacated and the action remanded for appropriate findings to be made. Where a full

understanding may be had without the aid of separate findings, however, the courts recognize a narrow exception to that general rule. [More Like This Headnote](#)

[Civil Procedure](#) > [Trials](#) > [Bench Trials](#) 

[Civil Procedure](#) > [Appeals](#) > [Standards of Review](#) > [Clearly Erroneous Review](#) 

HNS  The ultimate finding of fact in a case, whether initially by the trial court, or as affirmed on appeal, rests on the same underpinnings, i.e., the necessary subsidiary facts, supported by evidence of record, that lead to that ultimate finding. Where the district court has not misapplied the controlling legal standards in its evaluation of the evidence, its ultimate finding as well as the subsidiary findings upon which the ultimate finding necessarily depends, is subject to review on appeal under the clearly erroneous standard of Fed. R. Civ. P. 52(a). [More Like This Headnote](#)

COUNSEL: Frank J. Benasutti, of Philadelphia, Pennsylvania, argued for Appellant.

David J. Cushing, of Washington, District of Columbia, argued for Appellees. With him on the brief was Darryl Mexic.

JUDGES: Miller and Smith, Circuit Judges, and Re Judge. *

* The Honorable Edward D. Re. Chief Judge, United States Court of International Trade, sitting by designation.

OPINIONBY: SMITH

OPINION: [*1573] SMITH, Circuit Judge.

In this patent case, ACS Hospital Systems, Inc. (ACS), appeals from a judgment of the U.S. District Court for the Western District of Pennsylvania, 564 F. Supp. 330, [*1574] holding U.S. patent No. 4,183,057, issued to Sonnenberg (the Sonnenberg patent), invalid as obvious under 35 U.S.C. § 103 (1976) and not infringed. Montefiore Hospital and Wells National Services Corp. (Wells) cross-appeal from the district court's denial of their motion for attorney fees. The judgment is reversed with respect to invalidity and affirmed with respect to noninfringement. With respect to Wells' cross-appeal from the denial of attorney fees, the [**2] judgment is affirmed.

Background

ACS's Sonnenberg patent claims a rental television system comprising a key operated actuating switch, an override switch, and a signal light to indicate that the override switch has been actuated. When the key switch is in the "on" position, the television operates normally. For rental use, the key switch is placed in the "off" position by a key operator. In order to rent the television, the viewer depresses the override switch which enables the television to operate normally without the necessity of turning on the key operated switch. When the override switch has been activated the indicator signal is illuminated, signaling that the television has been rented. Claim 1 is representative:

A television system constructed for rental use, the television system comprising: actuating means including a key operated switch switchable between an off position for preventing normal operation of the television and an on position for enabling the television to be operated;
override switching means capable of being switched from a normal position to an

actuated position for overriding said key operated switch when in its off position and **[**3]** enabling the television to be operated; and said override switching means when switched in to [sic] its actuated position remains in said position until said key operated switch is switched into its on position; and indicating means for providing an indicating signal when said override switching means has been switched into its actuated position.

Validity

The trial court held the claims of the Sonnenberg patent invalid under section 103. While the trial court's opinion deals predominantly with Infringement, the court purported to apply the standards articulated in *Graham v. John Deere Co.* n1 In determining the issue of validity. In concluding that the Sonnenberg patent is invalid under section 103, the district court relied on override switches generally and ACS's "COMPU-TEL" fully automated television rental system as prior art.

----- Footnotes -----

n1 *Graham v. John Deere Co.*, 383 U.S. 1, 15 L. Ed. 2d 545, 86 S. Ct. 684 (1966).

----- End Footnotes -----

The court below stated that "the overriding of switches by providing **[**4]** an alternative path for current to actuate an appliance is a commonly practiced technique well known in the art prior to Sonnenberg's patent." It held that his claim 1 is therefore invalid as obvious. The trial judge adopted Wells' expert's description of ACS's COMPU-TEL system and held the Sonnenberg patent invalid as an attempt by ACS to "monopolize *all* systems of enabling a hospital patient to view television * * without the aid of an attendant." (Emphasis in original.) He commented that "the statutory presumption [of validity] of 35 U.S.C. 282 is entirely annihilated by the indisputable facts in the record."

Presumption of Validity

As an initial matter, we hold that the trial court's treatment of the presumption of validity is incorrect as a matter of law. ^{HN1} The presumption is *never* annihilated, destroyed, or even weakened, regardless of **[*1575]** what facts are of record. n2 Rather, it is a clear statutory procedural device which assigns to the party asserting invalidity the burden of proving invalidity. n3

^{HN2} A patent shall be presumed valid. * * The burden of establishing invalidity of a patent or any claim thereof shall rest on the party asserting such **[**5]** invalidity. n4

The burden of persuasion is, and remains always, on the party asserting Invalidity. n5 In the

present case this error is not harmless. The district court's holding of invalidity has been shown, on the entire record, to have been reached on the basis of *both* clearly erroneous findings of fact and misapplication of the law. n6

- - - - - Footnotes - - - - -

n2 Stratoflex, Inc. v. Aeroquip Corp., 713 F.2d 1530, 1534, 218 U.S.P.Q. (BNA) 871, 875-76 (Fed. Cir. 1983).

n3 *Id.*

n4 35 U.S.C. § 282 (1976).

n5 Stevenson v. U.S. Int'l Trade Comm'n, 67 CCPA 109, 612 F.2d 546, 551, 204 U.S.P.Q. (BNA) 276, 281 (1979); Solder Removal Co. v. U.S. Int'l Trade Comm'n, 65 CCPA 120, 582 F.2d 628, 632-33, 199 U.S.P.Q. (BNA) 129, 132-33 (CCPA 1978). See also Connell v. Sears, Roebuck & Co., 722 F.2d 1542, 220 U.S.P.Q. (BNA) 193 (Fed. Cir. 1983); Medtronic, Inc. v. Cardiac Pacemakers, Inc., 721 F.2d 1563, 220 U.S.P.Q. (BNA) 97 (Fed. Cir. 1983); Stratoflex, 713 F.2d at 1534, 218 U.S.P.Q. (BNA) at 875-76; Kalman v. Kimberly-Clark Corp., 713 F.2d 760, 773-74, 218 U.S.P.Q. (BNA) 781, 790 (Fed. Cir. 1983). **[**6]**

n6 Cf. Medtronic, 721 F.2d at 1566, 220 U.S.P.Q. (BNA) at 99 (errors in decisional approach considered harmless).

- - - - - End Footnotes - - - - -

Section 103

This court has in recent months issued a number of opinions addressing the analysis of obviousness under section 103 n7 and those opinions provide a comprehensive guide to analysis. We hold that the trial court's analysis of obviousness is inadequate under *Graham* n8 to sustain a holding of invalidity under section 103. However, the trial court's opinion contains sufficient findings of fact, supported in the record, to enable us to review the conclusion below that the Sonnenberg patent is invalid.

- - - - - Footnotes - - - - -

n7 In re Sernaker, 702 F.2d 989, 217 U.S.P.Q. (BNA) 1 (Fed. Cir. 1983); Orthopedic Equip. Co. v. United States, 702 F.2d 1005, 217 U.S.P.Q. (BNA) 193 (Fed. Cir. 1983); Orthopedic Equip. Co. v. All Orthopedic Appliances, Inc., 707 F.2d 1376, 217 U.S.P.Q. (BNA) 1281 (Fed. Cir. 1983); Chore-Time Equip., Inc. v. Cumberland Corp., 713 F.2d 774, 218 U.S.P.Q. (BNA) 673 (Fed. Cir. 1983); Schenck, A.G. v. Nortron Corp., 713 F.2d 782, 218 U.S.P.Q. (BNA) 698 (Fed. Cir. 1983); Environmental Designs, Ltd. v. Union Oil Co., 713 F.2d 693, 218 U.S.P.Q. (BNA) 865 (Fed. Cir. 1983); Stratoflex, 713 F.2d 1530, 218 U.S.P.Q. (BNA) 871. **[**7]**

n8 Graham, 383 U.S. at 17-18, 148 U.S.P.Q. (BNA) at 467, provides, in pertinent part:

"* * * [Section] 103 * * * ^{HN3} lends itself to several basic factual inquiries. Under § 103, the scope and content of the prior art are to be determined; differences between the prior art and the claims at issue are to be ascertained; and the level of ordinary skill in the pertinent art resolved. Against this background, the obviousness or non-obviousness of the subject matter is determined. Such secondary considerations as commercial success, long felt but unsolved needs, failure of others, etc., might be utilized to give light to the circumstances surrounding the origin of the subject matter sought to be patented. As indicia of obviousness or nonobviousness, these inquiries may have relevancy. * * *"

- - - - - End Footnotes- - - - - -Scope and Content of the Prior Art.

In determining the scope and content of the prior art, the trial court found that override switches generally were well known in the art. It also found that ACS's COMPU-TEL system was within the prior art under section 102(g). The district court did **[**8]** not in its opinion rely on any other prior art reference in determining whether the claimed invention would have been obvious under section 103.

Five U.S. patents n9 are cited in the Sonnenberg patent as prior art. Further, the parties refer to the "Western New York Hospital" rental television system as prior art. While the trial judge made no mention in his opinion of these additional **[*1576]** references, on the basis of the record before us, they each constitute prior art relative to the Sonnenberg patent. We hold that the trial court's limited assessment of the prior art was clearly erroneous in that the court below failed to find that these additional references are within the scope and content of the prior art. These errors, however, have not been shown to have influenced the trial court's judgment in this case and, accordingly, we consider them harmless.

- - - - - Footnotes - - - - -

n9 Norris, U.S. patent No. 2,856,474; Townsend, U.S. patent No. 3,188,384; Sargent, U.S. patent No. 3,335,421; Daniel, U.S. patent No. 3,631,444; and Kosco, U.S. patent No. 3,886,302.

- - - - - End Footnotes- - - - - **[**9]**

Differences.

With respect to the differences between the claimed subject matter and the prior art, the district court gave claim 1 of the Sonnenberg patent an extremely broad construction. It adopted the opinion of Wells' expert that the COMPU-TEL system contains every feature of claim 1. Hence, the court below found no significant differences between the claimed subject matter and the prior art. We hold that finding to be clearly erroneous. In addition, that finding reflects an erroneous construction of the claims.

The trial court in its discussion of obviousness, rather than ascertaining the differences between the claimed subject matter and the prior art, focused on the differences between the Wells and the ACS systems. In so doing, it adopted Wells' expert's explanation of the differences between claim 1 and the Wells system -- differences relating to literal infringement, not validity. We conclude that the trial court erred in adopting Wells' expert's interpretation of claim 1.

Differences between the prior art and the claimed invention are apparent from the record. First, while override switches are used in a wide variety of applications, the examples of **[**10]** override switches cited by the district court are not relevant to the claimed subject matter as a whole -- television rental systems. The district court made no attempt in its opinion to identify the differences between the override switching examples that it cited and the claimed subject matter.

Second, the record discloses that COMPU-TEL is a fully automated television rental system whereas the claimed invention involves human monitoring and control. While COMPU-TEL and the claimed invention both exhibit certain switching elements, the functions of the switching elements in the two systems are different. The fully automated operation of the COMPU-TEL system does not involve overriding a locked key switch. The patient switch in the COMPU-TEL system functions to actuate the television as well as to initiate billing. The override switching means claimed in the Sonnenberg patent, on the other hand, functions to provide an alternative current path to the locked key switch and to actuate the indicator light.

Third, the prior art of record that the court did not discuss also differs significantly from the claimed subject matter. The five patent references cited in the Sonnenberg **[**11]** patent involve a variety of lock, metering, and control systems. None of them, however, employs an override switching mechanism to overcome a key operated actuating switch. The Western New York Hospital system involves a three position key switch. Yet, that system differs from the claimed subject matter in that it too does not employ override switching means.

Hence, we hold the trial court's assessment, that there are no differences between the claimed subject matter and the prior art, was clearly erroneous.

Level of Ordinary Skill and Secondary Considerations.

Additionally, the court below made no express finding with respect to the level of ordinary skill in the art. The trial court's analysis, however, clearly indicates that the level of skill was considered to be quite low. We interpret the court's findings as fixing the level of ordinary skill in the art as that of a layman. That finding has not **[*1577]** been shown to be clearly erroneous. The court made no findings with respect to secondary considerations.

Claim Construction.

As noted above, the trial court's opinion reflects an extremely broad construction of the claims. Contrary to the **[**12]** district court's construction of the claims, the Sonnenberg patent does not claim "all systems of enabling a hospital patient to view television normally under his own power without the aid of an attendant." (Emphasis in original.) The court ignored express claim limitations governing the function of the switching means.

HN4 Claims are to be read and construed in light of the specification and the prosecution history of the patent. **n10** Further, claims should be so construed, if possible, as to sustain their validity. **n11** Applying these principles, the claims of the Sonnenberg patent should be given a far more limited construction than that given by the district court in holding the claims invalid. The claims are limited to a system in which override switching means function to override a key switch when in its "off" position, enabling the television to operate normally. The Sonnenberg patent does not claim "all" hospital rental systems capable of operation without an attendant. Claim construction is a question of law. **n12** We hold that the trial court's construction of the claims is incorrect as a matter of law.

----- Footnotes -----

n10 Fromson v. Advance Offset Plate, Inc., 720 F.2d 1565, 1570-71, 219 U.S.P.Q. (BNA) 1137, 1140-41 (Fed. Cir. 1983); Autogiro Co. v. United States, 181 Ct. Cl. 55, 384 F.2d 391, 397-99, 155 U.S.P.Q. (BNA) 697, 702-04 (1967). **[**13]**

n11 Carman Indus., Inc. v. Wahl, 724 F.2d 932, 937 n.5, 220 U.S.P.Q. (BNA) 481, 485 n.5 (Fed. Cir. 1983); Klein v. Russell, 86 U.S. (19 Wall.) 433, 466, 22 L. Ed. 116 (1874); Turrill v. Michigan S. & N.I. R.R., 68 U.S. (1 Wall.) 491, 510, 17 L. Ed. 668 (1864).

n12 Autogiro, 384 F.2d at 397-99, 155 U.S.P.Q. (BNA) at 702-04; LaSalle v. Carlton's Laydown Serv., Inc., 680 F.2d 432, 216 U.S.P.Q. (BNA) 276 (5th Cir. 1982); Studiengesellschaft Kohle mb H v. Eastman Kodak Co., 616 F.2d 1315, 206 U.S.P.Q. (BNA) 577 (5th Cir.), cert. denied, 449 U.S. 1014, 66 L. Ed. 2d 473, 101 S. Ct. 573, 208 U.S.P.Q. (BNA) 88 (1980).

----- End Footnotes----- -Obviousness.

Turning now to the determination of obviousness under section 103, we conclude that none of the references, either alone or in combination, would have disclosed or suggested to one of ordinary skill in the art the use of override switching means in a television rental system. The trial court's heavy reliance on the widespread use of override switches appears to be no more than hindsight reconstruction of the claimed invention. The **[**14]** court below identified no source, other than the Sonnenberg patent itself, for the suggestion to use override switching means in a television rental system.

HN5 Obviousness cannot be established by combining the teachings of the prior art to produce the claimed invention, absent some teaching or suggestion supporting the combination. n13 Under section 103, teachings of references can be combined *only* if there is some suggestion or incentive to do so. n14 The prior art of record fails to provide any such suggestion or incentive. Accordingly, we hold that the court below erred as a matter of law in concluding that the claimed invention would have been obvious to one of ordinary skill in the art under section 103.

----- Footnotes-----

n13 Orthopedic Equip. Co., 702 F.2d at 1012, 217 U.S.P.Q. (BNA) at 199; cf. In re Samour, 571 F.2d 559, 563, 197 U.S.P.Q. (BNA) 1, 4 (CCPA 1978) (noting the rule in the § 103 context and declining to extend that rule to § 102(b) rejections); Corometrics Medical Sys., Inc. v. Berkeley Bio-Engineering, Inc., 193 U.S.P.Q. (BNA) 467, 475 (N.D. Cal. 1977).

n14 In re Rinehart, 531 F.2d 1048, 189 U.S.P.Q. (BNA) 143 (CCPA 1976); In re Regel, 526 F.2d 1399, 188 U.S.P.Q. (BNA) 136 (CCPA 1975); In re Avery, 518 F.2d 1228, 186 U.S.P.Q. (BNA) 161 (CCPA 1975); In re Imperato, 486 F.2d 585, 179 U.S.P.Q. (BNA) 730 (CCPA 1973); In re Andre, 52 CCPA 1019, 341 F.2d 304, 144 U.S.P.Q. (BNA) 497 (CCPA 1965).

----- End Footnotes----- **[**15]**

[*1578] *Infringement*

The trial court found that the Wells system does not infringe the claimed invention, either literally or under the doctrine of equivalents. Once again adopting the testimony of Wells' expert, the court below found that "the Wells system does not contain the element of overriding a locked switch." The district court also found differences between the ACS system and the Wells device with respect to the mechanism and circuitry of the actuating switch as well as with respect to the indicator light.

These latter findings, however, will not support a finding of no infringement. The claims of the Sonnenberg patent are not limited to a specific switching mechanism or to specific indicator light circuitry. The district court appears to have compared the Wells system with ACS's commercial product, rather than with the claims of the Sonnenberg patent. ^{HN6} Infringement is determined on the basis of the claims, not on the basis of a comparison with the patentee's commercial embodiment of the claimed invention.

The district court's failure to supply more comprehensive findings of fact compounds the difficulty of appellate review, particularly in view of the **[**16]** complexity of the technical subject matter of this appeal. ^{HN7} Findings of fact are to be construed liberally in support of a judgment. Confined to the trial court's limited findings, we are forced to draw from the facts found those inferences that are necessary to support the ultimate finding that the Sonnenberg patent is not infringed by Wells. n15

----- Footnotes -----

n15 5A J. MOORE, J. LUCAS, MOORE'S FEDERAL PRACTICE para. 52.06[1] (2d ed. 1984).

----- End Footnotes -----

In this endeavor we are not ourselves finding those facts which the trial court failed to set out for us. As an appellate court, we lack the power to perform that exercise. ^{HN8} Where the trial court fails to make findings, the judgment will normally be vacated and the action remanded for appropriate findings to be made. n16 Where a full understanding may be had without the aid of separate findings, however, we recognize a narrow exception to that general rule. n17

----- Footnotes -----

n16 Pullman-Standard v. Swint, 456 U.S. 273, 292 n.22, 72 L. Ed. 2d 66, 102 S. Ct. 1781 (1982); 5A MOORE'S FEDERAL PRACTICE para. 52.06[2]. **[**17]**

n17 See 5A MOORE'S FEDERAL PRACTICE para. 52.06[2] n.4 and cases cited therein.

----- End Footnotes -----

^{HN9} The ultimate finding of fact in a case, whether initially by the trial court, or as affirmed on appeal, rests on the same underpinnings, i.e., the necessary subsidiary facts, supported by evidence of record, that lead to that ultimate finding. Where the district court has not misapplied the controlling legal standards in its evaluation of the evidence, its ultimate finding as well as the subsidiary findings upon which the ultimate finding necessarily

depends, is subject to review on appeal under the clearly erroneous standard of Fed. R. Civ. P. 52(a). n18 We examine the record in order to review the trial court's judgment, and the findings it made or necessarily had to have made to support that judgment and, thus, to conclude the controversy at this stage without unnecessary further expenditure of judicial resources, if possible.

----- Footnotes -----

n18 Cf. Pullman-Standard, 456 U.S. 273, 72 L. Ed. 2d 66, 102 S. Ct. 1781.

----- End Footnotes----- **[**18]**

The Sonnenberg Claims.

The Sonnenberg patent claims a rental television system having key operated actuating means capable of being overridden by an override switching means. An indicating means signals that the override switching means has been actuated. Once overridden, the switches and the indicator light remain in their overridden positions until the key operated switch is switched on, resetting the override switching and indicating means.

The Accused Infringing Device.

The Wells device also contains each of the three physical elements of claim 1 of **[*1579]** the Sonnenberg patent: (1) a key operated actuating switch; (2) a remote control actuating switch; and (3) an Indicator light. The district court, however, found that the Wells device does not contain the claimed limitation of overriding a locked switch -- a difference in function.

The Wells device is a modified version of a standard hospital/hotel/motel television receiver. The keylock in the Wells system actuates 5 switches: S1XA; S1XB; S1B; S1C; and S1D [Fig. 1].

[SEE ILLUSTRATION IN ORIGINAL]

In the Wells device, the jumper wires, provided by the manufacturer on switches S1B and **[**19]** S1C, are not removed. [Fig. 2.]

[SEE ILLUSTRATION IN ORIGINAL]

Switches S1B and S1C are shorted out by those jumper wires, rendering those switches electrically inoperable.

Additionally, switch S1D [Fig. 1] is "replaced" by relay RL-2 [Fig. 3] of the Wells remote control circuit.

[*1580] [SEE ILLUSTRATION IN ORIGINAL]

Relay RL-2 is connected in parallel with switch S1D and one of the leads to switch S1D is cut between switch S1D and the connection of the lead to relay RL-2 [Fig. 3]. Thus, the circuit through switch S1D is broken, rendering that switch electrically inoperable.

Unlike switch S1D which it replaces, relay RL-2 is not controlled by the key switch. Rather, switch S1 [Fig. 3], located on the remote control unit, operates relay RL-2 in the Wells device. When S1 is not depressed, relay RL-2 remains normally closed. When switch S1 is depressed, the coil in relay RL-2 is energized causing relay RL-2 to open. Similarly, switch S1D, which relay RL-2 replaces, was normally closed when the television was not rented and

was opened by turning the key switch to rent the television.

Switches S1B, S1C, and S1D, therefore, are disabled in the **[**20]** Wells device. The key switch operates only two switches -- S1XA and S1XB [Fig. 1] -- which control the delivery of power to the television receiver. When these switches are closed [positions 2 and 3] [Table 1], power is delivered to the tuner; when these switches are open [position 1] [Table 1], the circuit is broken and no power reaches the tuner.

[*1581] [SEE ILLUSTRATION IN ORIGINAL]

As manufactured, when the key switch of a standard receiver is in position 2 [Table 1], switch S1D is open and the television operates normally. Position 2 functions as an "on" setting in the standard receiver. In the Wells device, however, switch S1D [Table 1] has been disconnected and it has been replaced by relay RL-2. Relay RL-2 cannot be opened by manipulation of the key switch, as was switch S1D. Thus, the receiver cannot be actuated merely by turning the key switch to position 2 in the Wells device. n19 Switch S1 opens relay RL-2. The Wells receiver can be made fully operable only by depressing switch S1 [Fig. 3] while master on-off switches S1XA and S1XB are closed -- position 2 or 3 [Table 1].

----- Footnotes -----

n19 It appears that had RL-2 and S1D been wired in series, instead of in parallel with S1D disabled, the Wells device would exhibit the claimed "on" function.

----- End Footnotes----- **[**21]**

When the key switch is in position 1, power is interrupted and depressing actuating switch S1 will not actuate the receiver. The Wells key switch performs the same function in position 2 as in position 3. In both of those positions, while power is supplied to the tuner, the actuating switch S1 must be depressed in order to actuate the television. Thus, switch S1 does not override the key switch of the Wells device. n20 Switch S1 and the key switch are electrically independent in the Wells device [Fig. 4].

----- Footnotes -----

n20 Our assessment of the operation of the Wells device is based on the trial court's findings and on the documentary and testimonial evidence of record. It appears that only switches S1XA and S1XB are controlled by the key switch. Thus, our analysis supports the trial judge's implication that there is no functional difference between positions 2 and 3 of the key switch. The above analysis assumes that the key switch does not operate some third circuit that is actuated in either position 2 or position 3, but not both. We are aware of no evidence that such a third circuit fulfills the role of the key switch and is in turn overridden by switch S1.

----- End Footnotes----- **[**22]**

[*1582] [SEE ILLUSTRATION IN ORIGINAL]

In summary, the Wells device exhibits three modes of operation: (1) off -- locked out (switches S1XA and S1XB open); (2) rentable -- key position 2 or 3 and S1 not actuated (switches S1XA and S1XB closed and switch S1 open); and (3) rented -- key position 2 or 3 and S1 actuated (switches S1XA and S1XB closed and switch S1 closed). Normal operation of the Wells device can be achieved *only* by depressing S1 while the power is switched on (key

switch position 2 or 3). The invention claimed in the Sonnenberg patent, on the other hand, also exhibits three modes of operation: (1) "off" -- rentable (override switch not actuated); (2) "on" -- rented (override switch actuated); and (3) "on" -- key operation (key switch turned on and override switch not actuated).

On the basis of our examination of the record we infer that the district court necessarily found the following relative to the Wells device: (1) switches S1B, S1C, and S1D are disabled; (2) the key switch controls only switches S1XA and S1XB -- the master on-off switch; and (3) the receiver can be actuated only by depressing S1 while the key switch is in either position 2 **[**23]** or 3 (so that switches S1XA and S1XB are closed).

Literal Infringement.

These implied findings lead inexorably to the district court's express finding that the Wells device lacks the claimed limitation of overriding a locked key switch. Further, these findings indicate that the Wells device does not exhibit the claimed "on" key switch position.

Both the "on" and "off" positions recited in claim 1 correspond to the "on" positions [positions 2 and 3] of the key switch in the Wells device. The Wells device cannot be operated normally through the key switch alone, as is required by claim 1. Rather, switch S1 must be depressed in conjunction with power being supplied to the receiver through the key switch. Hence, on the basis of the record before us, we conclude that the district court's finding, that Wells does not literally infringe the claims of the Sonnenberg patent, is not clearly erroneous.

Doctrine of Equivalents.

While the district court purported to apply the standard articulated in *Graver Tank & Manufacturing Co. v. Linde Air Products Co.*, n21 it entered no findings on the issue of equivalence: whether the Wells device performs substantially **[**24]** the same function as the claimed invention in substantially the same way to obtain substantially the same result. n22 Yet, the court clearly implied that Wells does not infringe the Sonnenberg patent under the doctrine of equivalents and entered judgment to that effect.

----- Footnotes -----

n21 *Graver Tank & Mfg. Co. v. Linde Air Prods. Co.*, 339 U.S. 605, 607-09, 94 L. Ed. 1097, 70 S. Ct. 854 (1950).

n22 *Id.* at 608; *Sanitary Refrigerator Co. v. Winters*, 280 U.S. 30, 42, 74 L. Ed. 147, 50 S. Ct. 9 (1929).

----- End Footnotes -----

We infer that the district court necessarily found that the Wells device, lacking the claimed function of overriding a locked key switch, does not function in substantially the same way as the claimed invention. **[*1583]** That inference is supported by the record. Accordingly, we conclude that the district court's finding, that the Wells device does not infringe the Sonnenberg patent under the doctrine of equivalents, is not clearly erroneous.

Hence, we affirm in part the judgment of the district court **[**25]** insofar as it relates to the finding that the Wells device does not infringe the claims of the Sonnenberg patent, either literally or under the doctrine of equivalents.

Attorney Fees

The trial judge found that this is not an exceptional case and denied Wells' request for attorney fees. In order to prevail on its cross-appeal, Wells must establish that the trial judge abused his discretion in this regard and not merely, as Wells' attorneys contend, that the trial judge committed clear error. Wells has not demonstrated the requisite abuse of discretion, although it attempts to do so by demonstrating alleged fraudulent conduct by ACS before the Patent and Trademark Office. Fraud has not been shown. Nor have other facts been established that would demonstrate that the trial judge abused his discretion in finding that this case is not exceptional. Thus, we affirm the district court's denial of Wells' motion for attorney fees.

Conclusion

In summary, we hold that the district court committed both clear errors of fact and errors of law with respect to its resolution of the validity issue. The district court's conclusion that the Sonnenberg patent is invalid under section **[**26]** 103 is incorrect as a matter of law. We conclude that the trial court's finding, that Wells does not infringe the claims of the Sonnenberg patent, either literally or under the doctrine of equivalents, is not clearly erroneous. Additionally, we hold that the trial judge did not abuse his discretion in denying Wells' motion for attorney fees.

AFFIRMED IN PART AND REVERSED IN PART.

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